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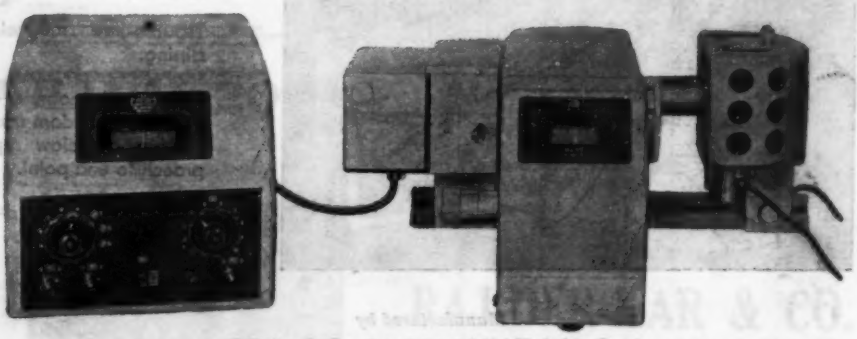

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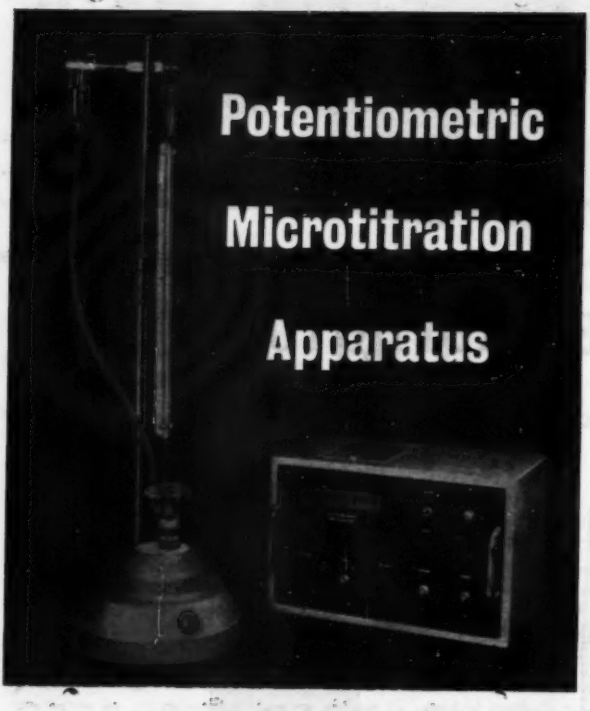

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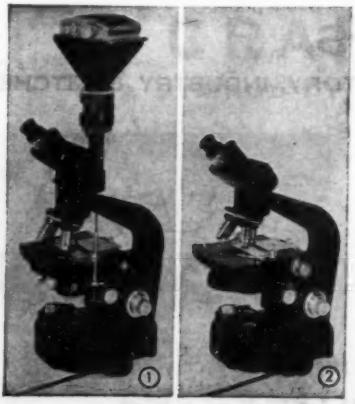

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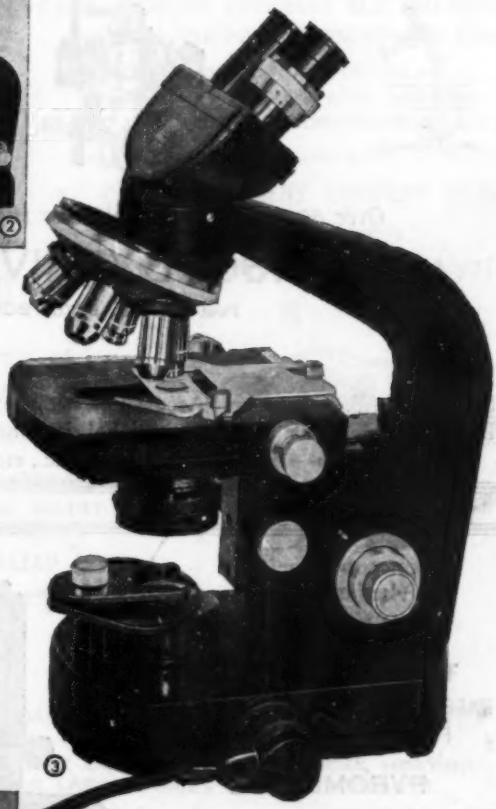

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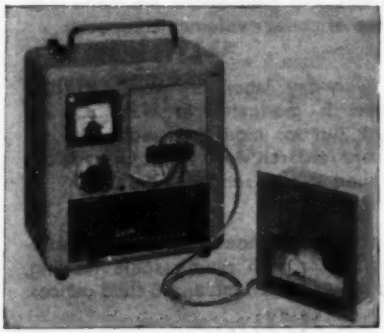

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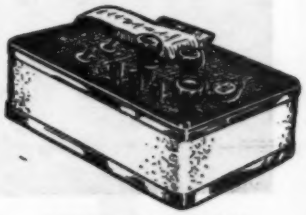

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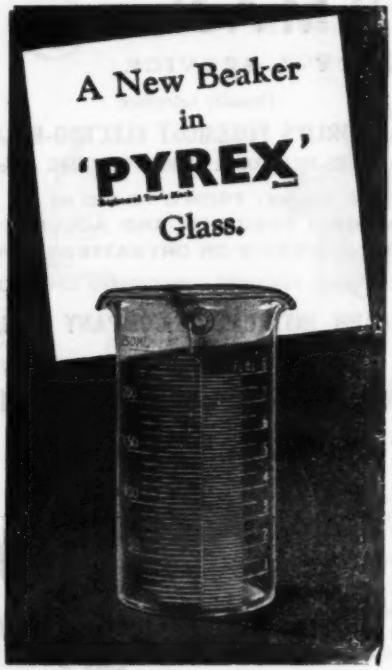

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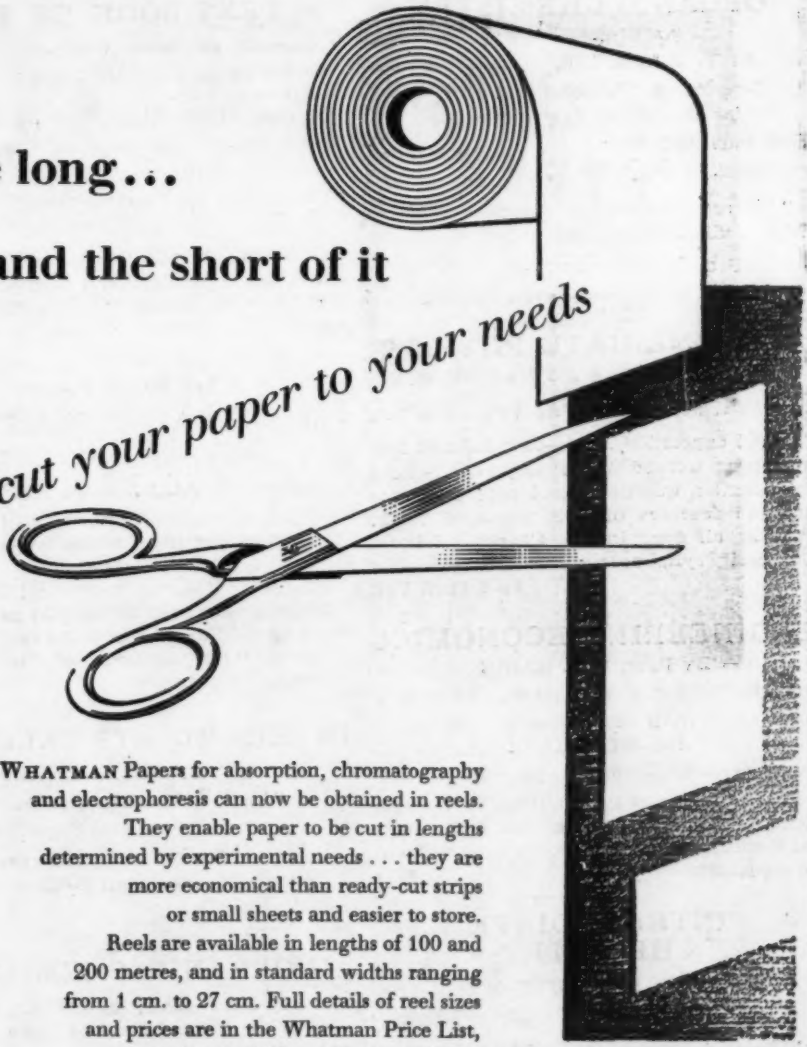

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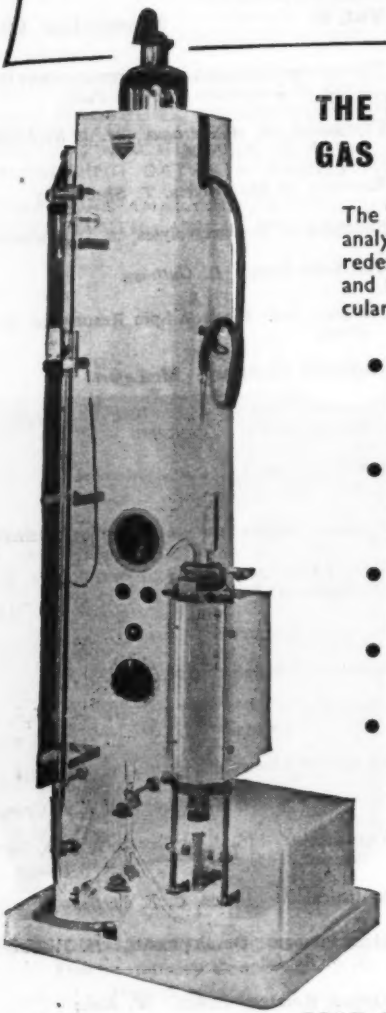

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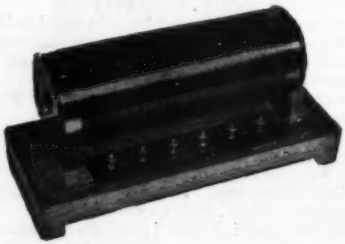

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IN observatories all over the world astronomers are examining excitedly the "pages" of a new sky atlas such as the world has never seen before—a superb map of the heavens which is already revealing secrets of the universe. Undertaken by the National Geographic Society (U.S.A.) and the California Institute of Technology which operates the Mount Palomar Observatory, the atlas is the first section of a giant map of the universe, the result of some seven years of intensive work.

Intriguingly, the results of this intensive study are already posing new queries, while the answers to others seem tantalisingly close.

One special piece of optical equipment—the "Big Schmidt" telescope—has brought reality to the astronomers' dreams by making it possible to photograph the heavens to a hitherto unprecedented depth in space—600 million light years. In reality Big Schmidt is a huge camera, named after its designer Dr. Bernhard Schmidt, a German optical specialist. It has a wide aperture lens measuring 48" across and a reflecting mirror of 72". It is a superb camera, penetrating with high fidelity ten times deeper into the heavens and covering a space volume a thousand times greater than any previous attempts, to chart the skies photographically. These qualities enable it to take pictures of hitherto unknown sharpness and clarity at enormous distances. A "light-year" is the distance light travels in one year—roughly six million million miles. The Big Schmidt can reach out some 600 million light years to obtain its pictures.

FIG. 1. Andromeda Nebula photographed with the Schmidt telescope.

Originally, this telescope was not designed specifically as a "camera" but rather as a "scouting instrument" for the 200" Hale telescope at Palomar Observatory. But in the Sky Survey it was soon found that the 48" Big Schmidt was of paramount importance. With its wide angle reflector, its telescope "eye" recorded on supersensitive film all visible objects in great cone-shaped slices of space, reaching out to an average distance of 2,000 billion billion miles. It accomplished in a few years a task for which the 200" Hale telescope would have needed 10,000 years or so, though the latter "sees" about three times as far.

Exploding Stars far Brighter than the Sun

Yet the Hale is vital too, for when the Big Schmidt discovers some unusual phenomena, they are studied intensively by the Hale telescope. The immense scope of the work may be better visualized when it is known that the new sky atlas will keep astronomers all over the world busy studying the results for an estimated period of 50 to 100 years.

When conditions are suitable, the Big Schmidt goes into action, but even then it is possible to obtain (usually) only four matching pairs of red and blue photographic records a night.

Each section of the sky is photographed on 14-inch photographic plates, through red and blue filters. This "double" exposure reveals more clearly, the colour, temperature and brilliance of distant stars, and moreover will enable astronomers to learn more about the "novæ" and "supernovæ"—those stars that suddenly and inexplicably explode and swiftly burn themselves out, amid a brightness estimated to be millions of times greater than that of the Sun.

In all, nearly three-quarters of the sky visible from Palomar have been photographed and recorded.

Almost from the beginning of the survey, astounding discoveries have been made. In 1950, for instance, the discovery of two new dwarf stellar systems in the Constellation of Leo was announced. Up to this time, the smallest known galaxies were estimated to possess a diameter of about 3,000 light years; the smallest among the newly discovered is estimated to have a diameter of only 1,500 light years, which suggests that perhaps even smaller stellar systems exist.

Galaxies Two Billion Light Years Away

Then, in 1951, came the announcement of a much more startling discovery, namely, that

there are more than 1,000 clusters of nebulæ in the heavens, as compared with the twenty known prior to the survey. These clusters are great masses of stars and gas, some as far as 350 million light years away.

FIG. 2. The 'Big Schmidt' telescope.

But the most revolutionary discovery of all was made by Dr. Walter Baade, early in 1953. Working at Palomar, Dr. Baade found that, contrary to scientific belief, all stellar systems beyond the earth's own galaxy (the Milky Way) are twice as far away as previously believed. The most distant galaxies visible through the 200" Hale telescope, Dr. Baade discovered, are two billion light years away.

What is the significance of this discovery? The observable universe has a volume eight times as great as believed, while its age is put at four billion years.

Almost daily new aggregations of stars and systems of stars, nebulæ like the Milky Way, are discovered. Of the Milky Way itself much new information has been added. In shape it is now seen as a great flat wheel of stars, slowly spinning in space, with "arms" of stars, gas and dust spiralling off its rim.

The foregoing is but a microscopic fragment of new knowledge about the universe which the sky atlas has already revealed. Equivalent in size to about 20 very fat volumes, the completed sky atlas will comprise 1,758 photomaps. The first section of the atlas is in the form of 14-inch unbound prints, totalling about 200 sky charts. Overall cost of one printing and handling only, and omitting all other expenses involved, will be about £ 712 ($ 2,000) per copy. By 1959, it is planned, all sections of the atlas will have been printed and despatched to the hundred or so observatories which have ordered it.

With its aid, perhaps we shall learn how large creation really is. We may even learn whether the universe is of uniform structure, and whether it had a definite beginning in space and time? Perhaps, also, we may discover whether the universe will end one day, or simply go on extending outward endlessly into space.—***UNESCO.***

ARIZONA METEORITE CRATER

DURING the summer of 1956, the smithsonian Astrophysical Observatory sent an expedition to investigate the distribution of pieces of meteoritic material that are scattered through the mantle of soil surrounding the Arizona Meteorite Crater, the object being to determine more accurately the mass of the meteorite that made the crater and also the direction of its flight.

Estimates of the total mass of finely divided meteoritic material around the crater suggested that this is about 12,000 tons, but this figure is subject to some uncertainty. It is believed that about one-fourth of this mass may be terrestrial oxygen that combined with the meteoric iron after its encounter with the earth. In addition, there does not appear to be any way for ascertaining accurately the amount of contaminating material present. After taking into consideration a number of uncertain factors, it is believed that the computed mass of 12,000 tons may have to be reduced by about 10-20%.

It is suggested that the meteorite approached the earth from a south-westerly direction, and after the collision threw forward large quantities of meteoritic material to the position where it now rests. As no piece more massive than 2,000 lb. has ever been found, while thousands of pieces weighing a few ounces or less have been recovered, it is believed that the meteorite was shattered into fragments when it struck the earth, melting and evaporation accompanying this disintegration. The results so far provide no indication as to whether a large mass of meteoritic material lies buried in the crater.

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IMPORTANT ANNOUNCEMENT

Enhancement of Subscription Rate of CURRENT SCIENCE with effect from 1st January 1959

INDIA: Rs. 12/- **FOREIGN: £ 1-4-0 or $ 4.00**

During the last seven years the size of CURRENT SCIENCE has steadily expanded, having increased from 40 pages per issue in the year 1952 to 68 pages at the present time. During the same period also the expenditure incurred in the conduct of the Journal has nearly doubled itself. In these circumstances, the Working Committee have been reluctantly compelled to increase the annual subscription in India from Rs. 8/- to Rs. 12/- and the foreign subscription from £ 0-15-0 or $ 2.50 to £ 1-4-0 or $ 4.00. In announcing this increase, the Working Committee are confident that the necessity for it will be appreciated by our readers and subscribers and that they will continue to give their whole-hearted support to the Journal.

RELATIVITY AND SPACE-TRAVEL

V. R. TIRUVENKATACHAR
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CAN one keep young by merely taking a round trip to outer space—say, to one of the fixed stars—and back? In other words, can interstellar travel be a recipe for perpetual youth? Fanciful as this question may appear at first sight, it has nevertheless been the object of protracted controversy in the recent scientific literature, owing largely perhaps to the increased interest in space-travel stimulated by progress in rocket—and missile—techniques, which has resulted in the successful launching of artificial earth satellites. While the connection between progress in propulsion techniques and the problem of space-travel is obvious, the effect of space-travel on the age of space-travellers may not be so apparent. The basis for expecting the existence of such an effect is provided by the theory of relativity according to which a moving clock goes slower, in comparison to a fixed one, at a definite rate, depending on its speed ("Einstein time-dilatation"). Thus if, of two otherwise identical observers A and B ("twins") originally at rest relative to each other, B begins to move away from A at a certain velocity on a spatial voyage and later returns home at the same velocity, his elapsed time as measured by his watch will be less than the elapsed time recorded by A who stayed at home. The returning astronaut would find that his stay-at-home brother had aged faster than himself. The matter was presented in a striking and entertaining way by Gamow.[1] Imagine a trip by B to Sirius and back in a rocket-ship travelling at nearly the speed of light. Assuming that Sirius is about seven light-years distant from the solar system, let us suppose that one fine morning B starts just at 6 A.M. in his rocket-ship and accelerates very rapidly (i.e., in a very short time) to a speed of, say, 99·9999995% of the speed of light. At this speed, reckoned by A's time, it will take B slightly more than seven years to reach Sirius and A will grow older by fourteen years while he awaits the return of his adventurous brother. Let us call the time required for B to reach Sirius exactly 60,000 hours. Now at the speed we have given B, the Einstein time-dilatation factor (see below) will be very nearly 10,000, so that 10,000 hours of A's time will correspond to 1 hour of B's time. According to B's reckoning, therefore, he will take only 6 hours to reach Sirius, arriving there exactly at noon. He then swings round and heads back for earth. We shall assume that this acceleration also consumes a negligibly short period of time. The return trip of 60,000 hours will again be recorded as 6 hours by B's sluggish clock so that in his view, he has returned home at 6 P.M. (again neglecting the final, very short period of deceleration) on the same day. But in the same period (*viz.*, the period of B's absence from home) A has aged 14 years!

This conclusion of the comparative youth of returning space-travellers was also stated and discussed by Sir George Thomson in his recent book[2]; and it has given rise to a prolonged controversy as to whether or not the existence of such an asymmetry in age between the twins is a legitimate deduction from the postulates of relativity.[3] We are confronted here with a matter of basic principles, quite apart from any possible consequences thereof for homesick astronauts. The difficulty—an old one known as *"the clock paradox"*—will become apparent if we observe that, according to the relativity postulate, B is equally justified in considering himself to be the stay-at-home and A the roving astronaut, so that now A could claim with equal justice that he was the one who should be younger. Who is right? How to decide who travelled and who stayed home? As long as A and B remain in relative motion at a distance apart and do not meet, there is no way of deciding who is right; the question has then no physical content. But if the twins having been originally together, separate and subsequently meet again, the situation is different because ages can be compared directly when the two meet again and the question can be settled without ambiguity. It can however be shown that there is really no paradox and that, whatever the view-point adopted, the stay-at-home, earth-bound twin will age at a more rapid rate than his wandering twin brother. In the next section we shall summarise the arguments leading to the stated result; in the third section we shall discuss the possible experimental verifications of the result; and in the final section we shall consider the practical implications for space-travel. (See also Macmillan.[4])

Suppose that A is at rest at the origin of an inertial frame S, while B has the same relation to another inertial frame S' and that the two

inertial systems S and S' are in relative motion with velocity V parallel to the x-axis (in S). We take the x'-axis in S' parallel to the x-axis. Let us further suppose that the clocks of A and B are set so that they each read zero when the two origins coincide, which defines the epoch of the beginning of the trip. The co-ordinates and the times in the two systems are then related by the Lorentz transformation:

$$x' = \beta (x - vt)$$

$$t' = \beta \left(t - \frac{vx}{c^2} \right)$$

where

$$\beta = \left(1 - \frac{v^2}{c^2} \right)^{-1/2}.$$

Suppose that at a certain instant a clock at $x = 0$ in S indicates a time t. Then a clock in S' at A's location (*i.e.*, a clock which coincided with A's clock at the instant in question) will indicate a time

$$t' = \beta t.$$

Reciprocally, if a clock in S' at B's location ($x' = 0$) indicates a reading t' then a clock in S at the same location $x' = 0$ will indicate a time

$$t = \beta t'.$$

This is of course "the Einstein time-dilatation"; relative to either system (regarded as "at rest"), clocks in the other system (regarded as "moving") will go slow. Returning to our problem of the twins, let us suppose that B moves with uniform velocity V relative to A except at the beginning, middle and end of the journey, when he is either accelerated or decelerated. We further suppose that the time-interval T (by A's clock) during which B is moving with uniform velocity is so large that the periods of acceleration and decelerations are negligible in comparison. The total time ΔT_A for the complete trip will be, according to A, 2 T. On the other hand, according to B (who considers himself to be at rest and A to be in motion) the time occupied is by the above formula

$$\frac{2T}{\beta} = \frac{1}{\beta} \Delta T_A$$

which is less than ΔT_A. There will thus be an unambiguous difference between the two results. Objection has been taken to this conclusion on the ground that this is incompatible with the relativity of all motion which, it is claimed, demands complete symmetry between the experiences of A and B. This cannot be admitted; for, as pointed out by McCrea,[5] the world-line of the observer on the earth is a geodesic while that of the traveller is not a geodesic (though it can be made up of parts of four different geodesics). This distinction between the two observers is an absolute distinction. (See also Eddington.[6] Eddington points out that the physical disturbance experienced by B is not uniquely related to the co-ordinate acceleration, which is purely relative.) This absolute distinction results in a distinction between the ways in which the two observers describe the relative journey. Moreover, when we take into account the accelerations which are necessary if the twins are to start and end with no separation in space and no relative velocity, we must take into consideration not only the relative motion of the twins but also of the rest of the universe. If B is to stand still and the earth, Sirius and the rest of the universe are to be accelerated to such a speed that for seven years Sirius is approaching B and the earth is receding, followed by the opposite motion of the universe during the next seven years, then the problem should properly be treated on the basis of the general theory of relativity. It is then found that on either point of view, the twin A who remains at home will age at the usual rate, while B will age at the less rapid rate as given above. This was pointed out many years ago by Tolman,[7] who gave a complete solution of the problem. We reproduce here the substance of Tolman's derivation. (See also Frye and Brigham.[8]) Suppose B is considered to be at rest while A and the rest of the universe are supposed to have the sequence of motions exactly opposite to that of B in A's description. In order to arrive at a description which shall be valid from either point of view, we may assume that changes in the relative motion of A and B are brought about by the temporary introduction of homogeneous gravitational fields which are allowed to act on A in such a way as to produce the desired changes in velocity. For the two time-periods Δt_A, Δt_B as given by A and B, we may write

$$\Delta t_A = t_A + t_A' + t_A'' + t_A'''$$

$$\Delta t_B = t_B + t_B' + t_B'' + t_B'''$$

where t_A, t_B are the time-intervals (according to A and B) during which A is now regarded as having a uniform velocity v, and t'_A, t''_A t'''_A and t'_B, t''_B, t'''_B are the times needed for the three changes in velocity of A which are brought about in the beginning, middle and end of the journey by the temporary introduction of gravitational fields. As mentioned earlier, we can take these latter intervals to be

very short, compared with the time-interval during which A is in uniform motion. We further suppose that $v \ll c$. Since the clock A is the one now in motion, we have in the first place

$$t_A = \frac{1}{\beta}\, t_B \simeq t_B\left(1 - \frac{1}{2}\frac{v^2}{c^2} + \cdots\right).$$

When the gravitational fields are introduced at the beginning and end, the two observers are at practically the same potential, so that

$$t_A' \simeq t_B', \quad t_A''' \simeq t_B'''.$$

On the other hand, when the gravitational field is introduced at the middle of the journey to produce the necessary reversal of A's motion, the two observers will be at a great distance from each other and in this case, on account of the difference in gravitational potential ($\Delta\psi$), we must write

$$t_A'' = t_B''\left(1 + \frac{\Delta\phi}{c^2}\right).$$

Here $\Delta\psi = gh$, where h is the distance between A and B; further

$$g = \frac{2v}{t_A''}$$

and

$$h = \tfrac{1}{2}\, v t_B$$

so that

$$t_A'' = t_B'' + t_B \cdot \frac{v^2}{c^2}.$$

Thus finally

$$\begin{aligned}\Delta t_A &= t_B\left(1 - \frac{1}{2}\frac{v^2}{c^2} + \cdots\right) \\ &\quad + t_B' + t_B'' + t_B \cdot \frac{v^2}{c^2} + t_B''' \\ &= t_B\left(1 + \frac{1}{2}\frac{v^2}{c^2} + \cdots\right) + t_B' + t_B'' + t_B''' \\ &= \Delta t_B + t_B \cdot \frac{v^2}{2c^2} + \cdots \\ &= \Delta t_B\left(1 + \frac{v^2}{2c^2} + \cdots\right) - (t_B' + t_B'' + t_B''') \\ &\quad \times \left(\frac{v^2}{2c^2} + \cdots\right).\end{aligned}$$

On account of the assumed smallness of t_B', etc., we may neglect the last term and get the end result

$$\begin{aligned}\Delta t_A &= \Delta t_B\left(1 + \frac{v^2}{2c^2} + \cdots\right) \simeq \frac{\Delta t_B}{\sqrt{1 - v^2/c^2}} \\ &= \beta \Delta t_B\end{aligned}$$

which is exactly the result obtained previously by direct application of the special theory of relativity (from A's point of view).

We now turn to possible experimental verifications of the results discussed in the previous paragraph. So far as the Einstein time-dilatation is concerned, this was verified by H. E. Ives[9] in the laboratory by observations on canal rays. (See also Ives.[10]) More recently, F. S. Crawford[11] has pointed out that measurements on the decay times of decelerated μ-mesons can be interpreted as providing proof of the asymmetical ageing of the twins (here μ-mesons). Another test has been proposed by G. R. Isaak[12] using π-mesons describing a circular path in a magnetic field. Isaac points out that if N_0 and N_s are the numbers of π-mesons at the same point (in the laboratory frame) but separated by one revolution, then N_s/N_0 should have different values according as to whether the time-dilatation is or is not effective and shows that at available energies, fields and radii of orbits, the difference between the two is appreciable, thus verifying the existence of asymmetry.

The discussicn in the last paragraphs having demonstrated the factual correctness of the asymmetry in age between the stay-at-home and the returned traveller, we may now ask: how significant is this conclusion from the practical standpoint, especially in view of recent successes in launching earth satellites, which imply the attainment of high velocities? However, even at one quarter of the velocity of light, the change in time-scale is only about 3% and in a round trip to the periphery of the solar system (say, the planet Pluto) which would occupy about 44 hours, the time gained would only be about 80 minutes. The gain would be far less at the more modest speeds attainable now or in the near future. Relativistic time modifications are thus negligible for travel within the solar system. It seems therefore that we have no choice but to concur with Sir George Thomson's conclusion that *"whatever the attractions of interstellar travel, perpetual youth is hardly likely to be an important one"*.

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THE SECTOR-VISUAL METHOD OF ELECTRON DIFFRACTION: THE MOLECULAR STRUCTURE OF TETRACHLOROETHENE

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(Contribution from the Richard B. Wetherill Laboratory of Chemistry, Purdue University)

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RECENTLY, in this laboratory,[1] a comparative study has been made of various methods of electron diffraction for molecular structure determinations. The potentialities of the visual method using sectored patterns have also been studied with several molecules.[2] We have now investigated the molecular structure of tetrachloroethene by the sector-visual method. Since the molecular structure of this molecule has been studied independently by the visual method using non-sectored patterns[3] and by the sector-microphotometer method,[4] it seemed interesting to be able to compare the results of the sector-visual method with those by the other two methods. Of further interest was the carbon-chlorine distance in this molecule in order to test Pauling's proposal[5] regarding the double-bond character of the C-Cl bonds in the chloroethenes.

Tetrachloroethene, obtained by Matheson and Company, was purified by fractional distillation under vacuum before use. Electron diffraction patterns were taken using an r^3-rotating sector in the new Purdue apparatus.[6] Electrons of wavelength 0·05452 Å were used with Kodak Lantern Slide Medium plates. The photographs were taken at camera distances of 10·19 and 25·04 cm.

A visual intensity curve was obtained, making use of six patterns, three taken at the long camera distance and three at the short camera distance. These sector-visual data extended from $q = 15$ to $q = 87$.

A radial distribution curve was calculated by equation[7]

$$r\,D(r) = \sum_{q=1,2,3,\ldots}^{q_{max}} I_m(q) \exp(-bq^2) \frac{\sin \pi q r}{10}$$

using I.B.M. punched cards. The value of b was chosen so that $\exp(-bq^2) = 0{\cdot}1$ at $q = 90$. The data for the range $q = 0$ to $q = 14$ were supplied from a theoretical curve. The radial distribution curve thus obtained is shown in Fig. 1.

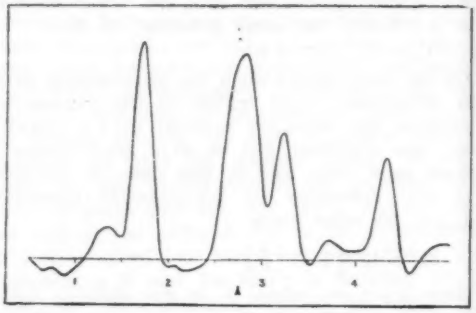

FIG. 1. Radial Distribution Curve for Tetrachloroethene.

The peak positions and the areas of each peak are listed in Table I. Also listed are the approximate mean amplitudes of vibration, $\overline{\Delta} r_{ij}$, for some of the peaks; these were obtained using the Karles' method.[8,9] The radial distribution curve shows some negative areas and other extraneous features. No attempt was made to improve the radial distribution curve by performing Fourier inversions on the extraneous features.[2] Experience has indicated that such an improvement would have no appreciable effect on the interatomic distances, but would improve the general appearance of the radial distribution curve.[1,2] There is, however, reasonable agreement of the peak areas with calculated values of $nZ_i Z_j / r_{ij}$. No attempt was made to decompose the third peak in the radial

TABLE I

Radial distribution results

Distance	Peak Position, Å	$\overline{\Delta} r_{ij}$	Area	nZ_iZ_j/r_{ij}
C—C ..	$1{\cdot}33_9$	..	17·4	11·4
C—Cl ..	$1{\cdot}72_4$	0·05	100	100
C—Cl / Cl—Cl (short)	2·82	.. / ..	159·9	148·9
Cl—Cl (intermediate)	$3{\cdot}22_5$	0·10	64·7	75·9
Cl—Cl (long)	4·32	$0{\cdot}06_3$	47	56·5

* Purdue Research Foundation Fellow in Chemistry, 1956–57. Standerd Oil Foundation Research Fellow in Chemistry, 1957–58.

distribution curve which is due to a combination of the C-Cl and Cl-Cl (short) distances. The ClCCl angle and the C-C distance calculated from the C-Cl, the Cl-Cl (intermediate) and the Cl-Cl (long) distances are 113° 18′ and $1{\cdot}32_7$ Å respectively. This calculated value for the C-C distance does not agree with the position of the C-C peak in the radial distribution curve, because of the small contribution of the carbon atoms to the scattering. The final parameters by the sector-visual radial distribution curve are compared with the results of Lipscomb[3] and Karle and Karle[4] in Table II. The

TABLE II

Final parameters of tetrachloroethene by the different methods

Parameter	Visual*	Sector-Visual†	Sector-Microphotometer‡
C—C ..	1·34±0·05 Å	$1{\cdot}32_7$ Å	1·30±0·03 Å
C—Cl ..	1·71±0·02 Å	$1{\cdot}72_4$ Å	1·72±0·01 Å
∠ClCCl ..	115° 36′	113° 18′	113°±1·5°

* Lipscomb, W. N.[3]
† This research.
‡ Karle, I. L. and Karle, J.[4]

C-Cl distance and the ClCCl angle from this investigation agree closely with Karles' results by the sector-microphotometer method and the C-C distance is within the limits of error reported by them.

From Table I it is seen that the mean amplitude of vibration of the *cis* Cl-Cl atom pair is much larger than that of the *trans*-Cl-Cl atom pair. This is probably because the contribution from the modes associated with bending of the ∠ ClCCl is quite appreciable. This is consistent with the spectroscopic information and the earlier observations.[4]

The results of this investigation together with the other results on the chloroethenes[3,10,11] indicate no regular trend in the C-Cl and C-C distances and dispute Pauling's proposal that there is an increase in the C-Cl distances in the chloroethenes as the number of chlorine atoms adjacent to the double-bond is increased.

Work on this and similar compounds indicates that the visual interpretation of sectored diffraction patterns gives results which are considerably more reliable than those obtained by the visual interpretation of non-sectored plates and only slightly less accurate than can be obtained by the sector-microphotometer method.

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ANOMALOUS TRANSMISSION OF X-RAYS BY SINGLE CRYSTAL GERMANIUM

THE anomalous transmission of X-rays through nearly perfect crystals was first observed by Borrmann and Campbell and has been discussed theoretically by Zachariasen. Hirsch and Von Laue. The effect has been measured in calcite by Schwartz and Rogosa and found to agree reasonably well with theory.

Since the anomalous transmission arises because the lattice planes of the crystal coincide with the nodal planes, of the X-ray standing wave field in the crystal, it is clear that any gross lattice imperfections will destroy the effect and even subtle crystal defects will seriously reduce the transmitted intensity. This suggests that the intensity of the anomalously transmitted beam should furnish a sensitive tool for the investigation of crystal perfection. In recent times it has been possible to grow single crystals of germanium which exhibit a high degree of crystal perfection as indicated by ordinary standards. It was accordingly decided to investigate the anomalous transmission of X-rays by good single crystal germanium, both from the point of view of the effect itself and from the point of view of its use as a tool in the investigation of crystal perfection. In this paper results are given which show how details of the imaginary part of the atomic structure factor of germanium can be measured using essentially perfect germanium crystals and also how sensitive the anomalous transmission is to such crystal defects as dislocations and elastic strain.

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ABNORMAL IONOSPHERIC BEHAVIOUR AT 10 METRES WAVELENGTH

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OBSERVATIONS on the galactic radio radiation at a wavelength of 10 metres are being made in this laboratory (17° 26′ N., 78° 27′ E.) continuously for the past few months. The experimental set-up consists of a broad-side array of thirty full-wave dipoles connected to a Marconi CR 150/3 type communication receiver, the i.f. output of which is further amplified, rectified and fed to an Esterline Angus recording milliammeter through a d.c. amplifier. The aerial pattern has half power beamwidth of about 8° in the east-west direction and about 11° in the north-south direction. At this wavelength, in the tropical regions, it is estimated that the influence of the ionosphere on the intensity of the received radiation will be considerable. Results of the detailed survey at different declinations, now being carried out, will be published elsewhere.

It is the purpose of the present communication to report a very interesting phenomenon observed on three different occasions. It was found that occasionally, for short periods of time, the received radiation intensity falls to zero, the record showing only the noise generated in the receiving circuits. The dates and times at which this phenomenon was observed are given in Table I. Photographs of the actual records are shown in Fig. 1.

TABLE I

No.	Date	Time of Occurrence I.S.T.	Fall Time in min.	Rise time in min.	Duration of minimum noise level in min.
1	28-1-1958	07·10–08·32	35	27	20
2	21-2-1958	06·28–08·05	26	11	60
3	2-3-1958	05·48–07·38	28	23	31

(The Indian Standard Time is 5 hr. 30 m. ahead of G. M.T.)

The main features of this phenomenon are as follows:

(*a*) It occurs in the early hours of the morning. The starting time seems to be related to the time of sunrise.

(*b*) The fall in intensity is gradual. The rise in intensity at the end of the phenomenon is uniformly rapid in all three cases. The duration for which the noise level is at a minimum is different on the three occasions.

(*c*) The minimum noise level in all cases corresponds to the internal noise generated in the receiving circuits.

It is obvious that this enormous decrease in received intensity must be due to total reflection of this radiation by the ionosphere. The occurrence of a solar flare would suggest itself as a possible cause for a violent disturbance in

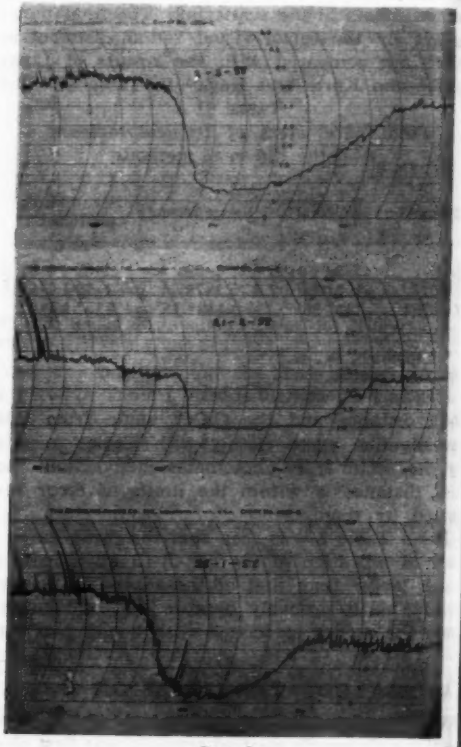

FIG. 1

the ionosphere resulting in the observed total reflection of radiation at this high frequency. A somewhat similar effect at 25 mc/s. was reported by Ramanathan and others (1956) from Ahmedabad at the time of the intense solar flare of February 23, 1956. But in all such effects of a solar flare the beginning is usually abrupt and the end is rather gradual. This is true of the records obtained by Ramanathan (*loc. cit.*). In the present case, however, the beginning is very much more gradual compared with the end of the phenomenon. Besides, neither the Nizamiah Observatory, Hyderabad, nor the Solar Observatory, Kodaikanal have reported the occurrence of any solar flare about or near this time. So solar flares are

ruled out as the possible cause of this phenomenon observed by the authors. The fact that on all the three occasions, the beginning of the phenomenon is closely connected with the time of sunrise also suggests that it is not due to solar flares. Another point of difference between the Ahmedabad observations and the present work is also of interest. The Ahmedabad workers do not report complete extinction of the cosmic noise as has been observed in the present case.

A possible explanation of the phenomenon might be the presence of a small-scale irregularity in the upper ionospheric layers. Calculation of the electron density necessary to reflect radiation of this high frequency shows that it should be at least ten times more than the normal values for the F_2 layer at this time of the day. If it is assumed that there is such a concentration of matter just before sunrise in these layers, then, as the sun rises above the horizon, the ionisation will gradually increase until the necessary density of electrons is produced to reflect back the cosmic radio waves. Meanwhile, the temperature of this region would be increasing setting up a process of diffusion resulting ultimately in a rapid disappearance of this conglomeration. The magnitude of the initial concentration of atoms and molecules determines the time for which this phenomenon is observed. Thus the density of matter must have been much higher on February 21, 1958, than on the other two occasions. This picture can also explain the reason for the occurrence of this phenomenon in the early hours after sunrise. During the day time, the possibility of finding high concentrations of molecules and atoms is remote. During the night, while such possibility exists, the necessary ionising radiation will not be available to provide the large electron density required.

The use of extra-terrestrial sources of radio radiation for the study of the ionosphere is now well established. But most of the work in this field is being done in temperate regions. The fact that no similar observation has been reported by these workers leads us to believe that this phenomenon may be peculiar to the tropical ionosphere.

SUMMARY

Cosmic radio noise observations at a wavelength of 10 metres reveal that ionospheric effects are considerable in the tropical regions even at this wavelength. On three different occasions, total reflection of the cosmic noise was observed, unrelated to any solar phenomenon, but closely connected with the time of sunrise. An explanation based on the assumption of a locally high concentration of matter in the upper ionospheric layers is given.

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LITHIUM DEVELOPMENTS

A CENTURY after Bunsen and Matthiessen first prepared lithium metal in sufficient quantity to permit its full examination, this alkali metal and its compounds have been promoted to a prominent place as regards applications in industry.

Lithium carbonate is now regarded as useful in enamels and glazes, as source of lithium chemicals; while the hydroxide is of widest use for conversion to lithium soaps for multi-purpose greases which resist water and weathering, for absorbing carbon dioxide in submarines and confined spaces since it is not deliquescent and does not form a cake of carbonate. In the alkaline storage battery, lithium hydroxide is included with potash to improve capacity. The hydroxide as monohydrate, the carbonate, the fluoride and even powdered lepidolite are all used in lithium glass production where decrease in coefficient of expansion and increase in strength are claims for this inclusion.

Yet lithium has gone much further than in the expansion of such applications first developed some years ago. In the intensive work on ramjet fuels, those hydroborons known as "H.E.F.s" or high-energy fuels, lithium and boron came under close examination in this new project begun a decade ago. Lithium was passed by at first, regarded as too rare for practical purposes; yet the use of lithium hydride for production of hydroborons by reaction with boron halides has brought back lithium into the ramjet field. Even if lithium metal, apart from de-gasification of copper has failed to find a useful role, this appreciation of the hydride, the possibilities of lithium for preparing tritium and of the isotope lithium 7 for control rods in fast reactors, all mark the attention being accorded Arfwedson's metal. Moreover, mere mention of lithium hydride brings up the increasing importance in organic synthesis, and that of lithium aluminium hydride, of lithium alkyls and aryls, of the metal itself in vitamin A synthesis.

SOME APPLICATIONS OF OXYGEN IN STEEL-MAKING

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THE detrimental effects of nitrogen on welding, cold-forming and aging of air-blown steel have been recognized in recent years. The pronounced effect of nitrogen on brittleness, particularly brittleness after cold work, has been shown by Work and Enzian.[1] The bessemer steels containing 0·012-0·018% nitrogen have become increasingly inadequate for meeting the more and more rigid specifications. The basic open hearth process can produce low nitrogen steels containing less than 0·005% nitrogen, but this process is not quite economical under the European conditions. It is interesting to note that only an increase of about 0·01% nitrogen in the bessemer steel over the basic open hearth steel necessitated the evolution of a new steel-making process for producing basic open hearth quality steels in Europe.

It had long been known that the steel bath in the converter remained low in nitrogen as long as the carbon content was above 0·5%. By stopping the air blast at some such carbon level and then blowing a mixture of pure oxygen with carbon dioxide or steam in the final step with additions of cold scrap or ore to control the temperature, European steel-makers have made considerable tonnage of low nitrogen Thomas converter steel in the past fifteen years.

The quality of a steel, however, is characterized not only by its nitrogen content but also by the total of other impurities—oxides, slag and gas inclusions. The development of Linde-Frankel process for the production of tonnage oxygen at reasonable cost stimulated the research of Austrian workers for the production of low nitrogen quality steels using pure oxygen for blowing. In 1953, plants were built at Linz and Donawitz in Austria based on the investigations of Rosner, Tenkler and others for making low nitrogen steel with oxygen blowing. This process was at once a success. At least fifteen plants employing this process are now under construction in eight different countries.

This process known as the L.D. Process (Linz-Donawitz process) consists in blowing oxygen at the top of the molten pig iron contained in tuyereless solid bottom converters similar in shape to the conventional converters through a retractable water-cooled copper-tipped lance at a high pressure (100-150 psi) to blow the slag aside and penetrate the metal beneath. The oxidation of the impurities in the molten pig iron, being highly exothermic, generated very high temperature (2,000-2,500° C.) and is controlled with cold additions of scrap and ore. Unlike the basic bessemer, phosphorus is burned out simultaneously with carbon, and sulphur is reduced to one-third to one-half. Refractory consumption is much less than in bottom blown converters and open-hearth. The steel made contained 0·004% nitrogen with 99·5% pure oxygen blast. The capital cost of the L.D. plant is said to be much less than that of open hearth plant of similar capacity, provided sufficient blast furnace capacity is available.

At present, the L.D. Process produces low nitrogen steel with hot metal containing less than 0·25% phosphorus. In Sweden a rotating top-blown oxygen converter has been developed to produce open hearth quality steel from high phosphorus hot metal.[2] The rotation of the furnace body at a maximum speed of 40 r.p.m. served to bring about intimate mixing of slag and metal, resulting in efficient dephosphorization. This has been called the Kal Do Process.

The steel experts of West Germany are perfecting yet another steel-producing technique so that up to 2% phosphorus can be removed substantially before the carbon is oxidized completely, thus eliminating the nitrogen pick up in the after-blow period of the basic bessemer.[3] In the Rotor process, as it is called, the hot metal is received in a rotating horizontal cylindrical vessel with a basic lining. The speed of rotation varies between 0·1 to 0·5 r.p.m. The oxygen is introduced in two separate streams—the primary oxygen is introduced beneath the surface of the metal bath through a water-cooled blow-pipe for oxidation of the impurities and stirring the bath, the secondary oxygen stream is directed over the surface of the bath for burning the carbon monoxide evolved during the refining process, resulting in better heat economy. The steel made contains 0·003-0·005% nitrogen and is comparable to open-hearth steel. It is said that the cost of erection of the rotor plant will be 60% of that of the open hearth of equivalent capacity and the cost of production is only 40% of that in open hearth.

It appears that India offers wide scope for the L.D. Process. We have plenty of good

grade ore but our fuel position is alarming. With the success of our five-year plans, our fuel position is likely to become acute in the foreseeable future. Also there is little scrap available in the country because of our low consumption of steel and distance prevents the return of scrap in large quantities to the steel-making centres. Under these circumstances, the L.D. Process is certainly a good competitor to the basic open-hearth process which has been dominating the steel-making show for a very long time. So any planning for increased steel production in our country should certainly devote serious thought to the L.D. Process. It is reported that part of the steel to be made at Rourekela will be by the L.D. Process.

Acknowledgement.—The author is thankful to Prof. A. A. Krishnan, Head of the Department of Metallurgy, for his interest in the preparation of this article.

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INDUSTRIAL RESEARCH AT GENERAL ELECTRIC*

THE author, a historian, with a special interest in modern science and technology stemming from a war-time association, presents the story of the establishment and growth of the Research Laboratory of the General Electric Company. He employs "the institutional approach' in his study, calculated to arrive at a detailed picture of the organizational and administrative practices of the Laboratory and the pattern of its scientific pursuits and accomplishments. Quite naturally, in this approach, the environment and motivation for the scientific activity get more attention than the actual processes and individual achievements.

At the turn of the present century, the electrical industry as a whole was rapidly approaching the outer limits of its fundamental scientific knowledge. Elihu Thomson, Charles Steinmetz and E. W. Rice, all of the General Electric Company, were the founding fathers of the Research Laboratory, where a band of workers untrammelled by production worries, were to pursue fundamental experimental investigations, search out scientific principles and develop new applications of such principles. From its inception in 1901 to the present day, the Laboratory has been a leading example of the major role of organized industrial research in twentieth century society, and a substantial part of modern electrical technology is the direct outcome of the work of the Laboratory.

Dr. Birr uses his skill as a historian to summarize the many problems and achievements of the Laboratory in its different phases over five decades and a half. The initial fifteen years were a period of spectacular activity, when under the inspiring leadership of its Director, Willis R. Whitney, a group of scientists, including William D. Coolidge, Irving Langmuir, A. W. Hill, Saul Dushman and W. C. White, made their brilliant contributions, both fundamental and applied, in the fields of incandescent lamps, radio and X-rays, and laid in a firm foundation for a venture in industrial research. After the interrugnum of World War I, which diverted attention from the study of fundamental scientific phenomena to the development of anti-submarine devices, night-signalling lamps, detonators, smoke-screens and the like, the Laboratory picked up its main threads again. In this period, extending to the early thirties, the Laboratory, mature but no longer a unique institution and facing severe competition from many quarters, forged steadily ahead, and gave to technology many new ideas, techniques and products. Among such are the sodium vapour lamp, improved neon lamps and photocells, the screen-grid tube, the thyratron, the magnetron and the thoriated tungsten filament; the dynamic loudspeaker and the magnetic pick-up; X-ray tubes based on the cascade principle; high frequency induction heaters; improved types of magnetic sheet steel; new welding processes; new methods of stress analysis of fast-moving shafts and metal parts; new lubricants; the mercury vapour turbine; high temperature corrosion-resistant alloys; cemented tungsten carbide (carboloy); and glyptal resins. Then came the depression decade during which the Laboratory, despite very trying conditions, carried on with its earlier interests and also formed new ones. It developed the Betatron, produced a new class of permanent magnet alloys, new organic insulating materials and silicon resins, oils and rubbers, and inves-

* *Pioneering in Industrial Research—The Story of the General Electric Research Laboratory*, By Kendall Birr. Published by Public Affairs Press, Washington, D.C., 1957, p. 204. Price $ 4.50.

tigated several problems in powder metallurgy, creep in metals and embrittlement of copper. In 1932, honour and prestige came to the Laboratory with the Nobel Prize awarded to Langmuir for his fundamental work in Surface Chemistry.

Drawn into the war effort during World War II, the Laboratory made a variety of contributions in the fields of electronics and radar, X-rays for metallurgical inspection, silicons, carbon brushes, rocket motors, precision castings, etc.

In the post-war era, to meet challenging conditions created by the problems of financing, personnel procurement, accommodation requirement and an increasingly complex patent situation, the Laboratory has had to reorganize itself in a major way. But the main objective has survived—research, much of it of a fundamental nature. Work in two new areas, experimental meteorology and atomic energy, was inspired by war-time developments. In the latter field, the Laboratory has helped to develop nuclear reactors to power submarines and for commercial atomic power. To aid in fundamental physical research and also for a variety of practical applications, the Laboratory has built Betatrons and Synchrotrons. There has been a massive revival of interest in electronic research, in keeping with the vastly important role of electronic processes in modern technology. Out of the Laboratory have come high frequency tubes, television tubes, ceramic metal seals that presage revolutionary changes in tube design, and, above all, semi-conductors. The phenomenon of electro-luminescence has been studied, and light amplification has been achieved. There have been systematic investigations into the theory and practice of metallurgy, crystal growth and nucleation. High temperature alloys, improved ferromagnetic materials, rocket fuels and man-made diamonds are among the newer products of the Laboratory.

The author points out that a cardinal factor in the growth and functioning of the Laboratory is its continued faith and interest in fundamental, exploratory research, based on a clear recognition of 'the cross-disciplinary nature' of modern scientific activity. According to C. G. Suits, its present Director, "From basic research we achieve what appears to be an answer to a problem; we then search through our complex technology for the problem." The main reasons for the continued success of the Laboratory are not far to seek. The top management of the parent Company genuinely believed in the importance of research. With its broad technical interests, the Company was a kind of a protective giant, using its engineering skill, financial resources and marketing competence to exploit commercially the Laboratory's discoveries. From within, the success was due to the quality of her research scientists, the comparative freedom in which they functioned, the *esprit de corps* and the enlightened leadership, especially in the formative years. The programme of work strove always to strike a balance between development work, some trouble-shooting and a fair amount of fundamental work.

The book is fascinating reading material for the technical as well as the non-technical reader with an interest in industrial research. The author's analysis of the phenomenal success of the Laboratory, in an overall assessment, and his description of the administrative and laboratory procedures and the effective way in which financing, personnel selection and related problems were faced from time to time, deserve the closest attention of those who are in charge of Industrial Research Planning in this country.

S. SAMPATH.

DECORATION OF DISLOCATIONS

IT has been known for several years that dislocations can be "decorated" by impurity atoms. This is usually done by adding a predetermined quantity of impurities in solid solution, straining and then heat-treating. In metals, two processes are then possible: (i) The diffusion of impurity atoms to the dislocations, producing the so-called "atmospheres", and (ii) the nucleation of precipitates at dislocation sites. Through subsequent etching, the atmospheres or the precipitates, and thereby the dislocations, can be revealed. This technique makes it possible to investigate dislocation patterns on the original surface as well as in the bulk of the metal, because layers of determined thickness may be removed at will by electrolytic polishing. Since the distance between dislocations may be as small as a few hundred angstroms it is advantageous—and for detailed conclusions even necessary—to examine the specimens with an electron microscope.

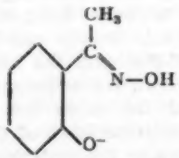
LETTERS TO THE EDITOR

SOLUTION STABILITY CONSTANTS OF SOME METAL CHELATES OF *o*-HYDROXY-ACETOPHENONE OXIME

THE values of $\log.K_i$ (concentration constants) of the series of reactions

$$M(HL)_{i-1} + HL \rightleftharpoons M(HL)_i$$

where M stands for a metal ion, HL for the ligand



and i varies from 1 to 2 or 3 as the case may be, have been measured at 30° C. in a 75% dioxan-25% water medium, by the Calvin-Bjerrum-pH titration method as modified by Irving and Rossotti.[1] The experiments were carried out under an atmosphere of nitrogen using LN-pH Indicator No. 7666 and LN Std. 1199-30 (one black dot) glass electrode in combination with LN Std. 1199-31 saturated calomel electrode. The concentrations of the metal salt and reagent in the titrated solutions were 0·0005 M and 0·002 M respectively. The solutions contained 0·02 M free $HClO_4$ and 0·1 M $NaClO_4$ also, the latter to maintain the ionic strength constant. Measurements were made with sulphates of Mn^{++}, Co^{++}, Ni^{++}, Cu^{++}, Zn^{++}, Cd^{++} and Mg^{++}. The relevant formation curves and the log.K values are given in Fig. 1 and Table I respectively.

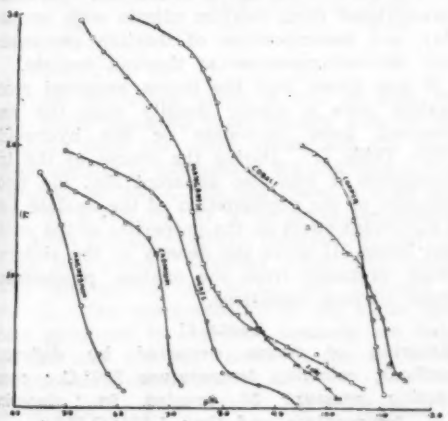
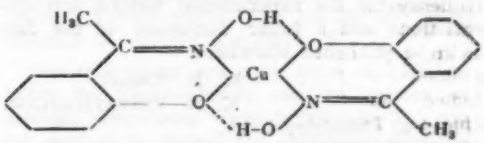


FIG. 1. Formation curves of the metal-ligand systems for metal chelates of *o*-hydroxy-acetophenone oxime at 30° C., $\mu \sim 0{\cdot}1$ M and in a medium of 75% dioxan − 25% water.

TABLE I

Metal		$\log.K_1$	$\log.K_2$	$\log.K_3$
Cu	..	10·15	11·23	..
Ni	..	7·55	7·25	..
Co	..	11·20	9·475	7·65
Mn	..	7·57	7·35	7·13
Zn	..	8·85	..	..
Cd	..	6·95	..	..
Mg	..	5·23	4·97	..

The log.K values show some interesting features. For Cu $\log.K_2 > \log.K_1$. This result can be associated with the formation of the two hydrogen bonds in addition to the metal-electron donor bonds when the second molecule of the ligand is added to the 1 : 1 complex, if the structure of the final complex is



as can be inferred from the known structure of the corresponding copper derivative of salicylaldoxime.[2] The order of $\log.K_1$ values is Co > Cu > Zn > Mn ≈ Ni > Cd > Mg. The order Cu > Ni > Cd > Mg is that followed by practically all log.K data reported for these metals with other ligands. However, considering only the transition elements studied here, it is seen that their $\log.K_1$ values do not follow the Irving-Williams order.[3] Previous physicochemical investigations on metal chelates of salicylaldoxime lead one to believe that in the systems studied here, there are present some of the factors discussed by Irving and Williams[3] as responsible for the derangement of the order. Thus the possibility of orbital stabilisation, *i.e.*, the use of "inner" orbitals by the metal ions is indicated by the work of Ray and Sen,[2] Cox *et al.*,[4] Kozo Sone[5] and Fujii and Sumitani.[6] In

that case, as is well known, the cobaltous compound would be easily oxidised to the cobaltic state. That $\bar{n}$ values greater than 2·00 are obtained in the Co titration lends support to this conclusion. Oxidation to the higher valence state and orbital stabilisation would hence explain the very high value of $\log.K_1$ in the case of Co. Similarly since $\bar{n}$ values up to 3·0 are obtained in the case of Mn, this ion is also oxidised in solution to the manganic state, thus accounting for the relatively higher value of $\log.K_1$.

The data obtained for Ni are also interesting. If Ni were using the "inner" dsp^2 orbitals to yield a planar chelate molecule, $\log.K_2$ would be expected to be greater than $\log.K_1$ as for Cu. This result is not obtained. Further the formation curve for Ni resembles that for Cd rather than that for Cu, and Cd, as is well known, cannot use any inner orbital in complex formation, it being a non-transition element. It might therefore be possible that Ni is not using the "inner" orbitals under the experimental conditions employed but rather yields a tetrahedral or octahedral complex using "outer" orbitals. Support for this belief arises from the magnetochemical investigations on Ni-bis-salicylaldoxime in solvents capable of donating electrons readily such as pyridine.[7] And dioxan can also donate electrons through its two oxygen atoms.

Details of the experimental method and calculations and a fuller discussion of the data will be published elsewhere.

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K. A. VENKATACHALAM.

Physical Chemistry Labs.,
Institute of Science,
Bombay-1, *March* 31, 1958.

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SINTERING OF THORIA

HIGH density thoria bodies have been prepared either by hot pressing at temperatures over 1,700° C. or by cold compacting and sintering at about 1,500° C. with the help of additives. A summary of the results of previous workers is given in Table I.

TABLE I
Density of sintered thorium oxide

Material	Sintering Temperature °C.	Density g./c.c.	Remarks
ThO_2+0·5% CaF_2 ..	1,500	9·6[1]	Cold compacting
ThO_2+0·5% CaO ..	1,700	9·8[2]	
Pure ThO_2 ..	1,500	8·1[1]	
Pure ThO_2 ..	1,650	9·0[3]	Hot pressing
Pure ThO_2 (from corbonate or oxalate)	1,450	9·0[3]	

From the above table it will be seen that the maximum density of pure thoria obtained by cold compacting and sintering at 1,500° C. so far reported is only 8·1 g./c.c. (theoretical 10 g./c.c.) and this density can be increased to a figure of 9·6-9·8 with the help of additives. It has been known for sometime that calcining temperature of the oxide has a considerable effect on the characteristics of the powder produced and hence on the sintering behaviour and the object of the present investigation was to see whether it would be possible to get a higher density of the sintered oxide by controlling the calcining temperature.

The starting material was thorium nitrate and the thoria used for the sintering studies was made by (*a*) direct ignition of thorium nitrate, (*b*) decomposition of thorium hydroxide (precipitated from thorium nitrate with ammonia), (*c*) decomposition of thorium carbonate, and (*d*) decomposition of thorium oxalate.

It was found that the thoria prepared from oxalate gave a higher density than the one prepared from carbonate or the hydroxide (*vide* Table II). During the course of the investigation it was also apparent that the temperature of the precipitation of the oxalate had a significant effect on the properties of the oxide and Table III gives the density of the sintered oxide prepared from the oxalate precipitated under various conditions.

TABLE II
Sintering of thoria prepared by different methods, calcining temperature 900° C.; compacting pressure 30 tons/sq. in., sintering temperature and time 1,500° C./1 hr.

Material (from which oxide is prepared)	Temperature of precipitation °C.	Density g./c.c.
Thorium hydroxide ..	30	7·86
Thorium carbonate ..	30	8·09
Thorium nitrate ..	..	8·20
Thorium oxalate ..	30	9·35

TABLE III

Sintering of thoria prepared from thorium oxalate; compacting pressure 30 tons/sq. in., sintering temperature and time 1,500° C./1 hr.

Pricipitation temperature ° C.	Sintered density g./c.c.
10	9·43
20	9·47
30	9·35
35	9·26
40	9·19
50	8·85
60	8·67

Table IV gives the effect of calcining temperature of the oxalate precipitated at different temperatures, on the sintered density (30 tons/sq. in., 1,500° C./1 hr.).

TABLE IV

Density of thorium oxide prepared from thorium oxalate

Temperature of precipitation °C.	Temperature of calcination °C.	Density g./c.c.
20	800	9·11
	900	9·47
	1,000	9·20
30	800	9·26
	900	9·35
	1,000	9·30
35	800	8·95
	900	9·26
	1,000	9·07

From the above tables it will be seen that the oxide prepared from oxalate behaves differently from the other oxides and the maximum density is obtained at the calcination temperature of 900° C. In particular a high density of 9·47 g./c.c. at a sintering temperature of 1,500° C.—the highest recorded so far for pure thoria—was obtained when the oxalate was precipitated at 20° C. and calcined at 900° C. The characteristics of the oxide powders produced by various methods are being studied and the full results of the work will be published elsewhere.

Metallurgy Division, S. K. KANTAN.
Atomic Energy Establishment, R. V. RAGHAVAN.
Trombay, *April* 18, 1958. G. S. TENDOLKAR.

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ULTRASONIC ABSORPTION MEASUREMENTS IN $MgSO_4$, $ZnSO_4$, $CoSO_4$ AND $NiSO_4$ AT 3 Mc./Sec.

ACCORDING to classical theory of Stokes, sound waves in liquids suffer an energy loss because of shear forces which causes an absorption coefficient α proportional to the square of frequency ν. The constant (α/ν^2) is given by the shear-viscosity of the liquid. Only few liquids such as mercury, conductivity play an important part in sound absorption. In nearly all liquids, the sound absorption considerably exceeds the classical value, thus indicating that there are some other energies which are causing this sound absorption. The energy losses may be caused by the retarded transition of energy between different degrees of freedom or chemical or structural arrangements of the molecules.

It is known from many measurements that aqueous solutions of many salts, especially 2-2 valent electrolytes, have noticeably higher absorption than pure water. Ultrasonic absorption measurements in electrolytic solutions have been made by a large number of workers. The work has been summarized by Sette.[1] Most of the investigators worked with $MgSO_4$ because of its high absorption.

In the present investigation ultrasonic absorption in $MgSO_4$, $ZnSO_4$, $CoSO_4$ and $NiSO_4$ were made using diffraction method at 3 Mc./sec. at various concentrations. The results for $MnSO_4$ solution is reported elsewhere.[2,3]

The absorptions are quite large at 3 Mc./sec., hence the measurements can be carried out through progressive wave technique. The optical method is chosen for absorption measurements. The absorption measurements are made using Debye and Sear's technique. Variation in the intensity of the light beam is recorded by means of a DuMont type 6291 photomultiplier tube. Suitable crystal-holders for working in electrolytes have been designed. The crystal-holder designed is long enough to move through long distances and thus very low absorption coefficient can be measured.

The results of the absorption measurements for $MgSO_4$, $ZnSO_4$, $CoSO_4$ and $NiSO_4$ at 3 Mc./sec. and 25° C. are as shown in Table I. Results for water is also given in the same table, to show the accuracy of the measurements. The results obtained by other investigators in case of water is shown in Table I for comparison of the results with the present investigations.

TABLE I

$(a/r^2) \times 10^{17}$ *sec.*^{2} *cm.*$^{-1}$

Conc.	0·05	0·1	0·2	0·4	0·6	0·8	1·00
$MgSO_4$ ..	40	60	100	170	245	280	320
$ZnSO_4$ ..	50	85	140	200	250	280	320
$CoSO_4$ ..	55	90	145	220	270	300	340
$NiSO_4$ ..	35	55	100	160	200	240	280
Water (Author)				..	28		
Water (Other investigators)				..	25–30		

ACKNOWLEDGEMENT

The author would like to express his sincerest thanks to Dr. G. S. Verma under whose guidance the present investigations were carried out and to C.S.I.R. for the Research Grant.

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University of Allahabad,
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THE RAMAN SPECTRUM OF PYRIDINE N-OXIDE

DURING our studies on molecular structure and chemical reactivity of heterocyclic N-oxides, we had occasion to obtain the Raman spectra of pyridine and substituted pyridine N-oxides. The Raman spectrum of pyridine N-oxide has been recorded for the first time. A Hilger Raman source and a Fuess glass spectrograph have been used.

The Raman frequencies of pyridine N-oxide are given below with the usual convention :

186(1 b), 232(1 b), 520(1), 553(1), 596(2), 624(1), 686(4), 730(1), 767(6), 841(1 b), 989(1), 1017(3), 1050(3), 1104(1), 1157(2 b), 1217(3), 1254 ± 10(3 b), 1382(2), 1509(1), 1558(1) [C = N], 1613(8) [C = C], 1893(2 b), 2034(2), 2100(1), 2233(1), 2495(2), 2826(1), 2874(2), 2918(3), 2954(1), 3046(4), 3086(1).

The band observed in the spectrum of pyridine N-oxide at 1254 ± 10 cm.$^{-1}$ is absent in that of pyridine. This band is assigned to the N → O stretching vibration. This assignment is in conformity with the results obtained by Blasina and co-workers[1] [1242 cm.$^{-1}$] and Wiley and Slaymaker[2] [1266 cm.$^{-1}$] from infrared studies.

It is also observed that the double-bond frequencies that are characteristic of pyridine[3] are altered cossiderably in pyridine N-oxide. These changes may be explained on the basis of different resonance forms that are possible for pyridine N-oxide.

Details of this investigation along with those relating to the substituted pyridine N-oxides will be published elsewhere.

Chemistry Dept., K. RAMIAH.
Osmania University, V. R. SRINIVASAN.
Hyderabad-7,
April 22, 1958.

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RESORCINOL AS A REAGENT FOR THE SPECTROPHOTOMETRIC DETERMINATION OF URANIUM

IN recent years, a number of organic reagents such as dibenzoylmethane,[1] salicylic acid,[2] etc., have been proposed for the colorimetric determination of uranium. Earlier, it was observed by Sienssen[3] that resorcinol produces an orange-red colouration when treated with an uranyl salt. In view of its high solubility in water and easier availability, it was thought that resorcinol might prove as a useful reagent for uranium and an investigation of the system, uranyl acetate and resorcinol, has been made.

Aqueous solutions of uranyl acetate M/40, and resorcinol (M/20), when brought together to interact in different proportions red, to deep red-coloured solutions were obtained which showed appreciable absorption at 400-10 mμ, depending on the concentration of uranyl ion. There was little change in the optical density of the solutions even after 48 hours and also even after heating to about 60° C. The composition of the product was determined by Job's continuous variation method at 400 mμ, and was found to be 1 : 2 between UO_2^{++} ion and the reagent. An attempt to determine the composition of the coloured product by conductivity and pH titration methods had failed possibly due to the fact that the compound formed is highly dissociated in solution and that one of the constituents of the product is a free acid :—

$$UO_2(CH_3COO)_2 + 2C_6H_4(OH)_2 \rightleftharpoons UO_2(C_6H_5O_3)_2 + 2CH_3COOH.$$

The system obeys Beer's law at the concentration of UO_2^{++} ion between $0{\cdot}125\ M \times 10^{-3}$ and $1{\cdot}25\ M \times 10^{-3}$ and at higher concentrations

However, there is a deviation at concentrations below $1{\cdot}25\,M \times 10^{-3}$. The sensitivity of the reagent is approximately up to M/32,000 (7·43 p.p.m.) of UO_2^+ ion, in excess of resorcinol. Most of the common cations and anions interfere with the determination but, a few ions like Cl^-, SO_4^{--}, NO_3^-, do not interfere unless they are present in large quantities. Detailed results of this investigation will be published later elsewhere.

Our thanks are due to Prof. A. K. Bhattacharya, Head of the Department of Chemistry, for providing facilities for carrying out this work.

Dept. of Chemistry, P. C. JAIN.
University of Saugar, G. S. RAO.
April 2, 1958.

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INACTIVATION OF *AZOTOBACTER* BY HEAT

STUDIES of several workers on the fluctuation of soil nitrogen in different parts of India have shown that there is a well-defined seasonal fluctuation of the same.[1,4,6,8–11] These appear to indicate that there are periods within a year when the nitrogen fixation processes are active in the soil and there are periods when the processes leading to the loss of nitrogen are predominant. High increase in population of nitrogen-fixing microflora in the soil immediately after the soil is moistened by the first rains is one of the noticeable features of some of these studies.

Extreme desiccation of the surface soil and the prevailing high temperature of summer days in Northern India would make nitrogen-fixation by any non-spore-forming mesophil like *Azotobacter* difficult in summer, though recent studies indicate that *Azotobacter* may function in the more moist subsoil or the rhizosphere even under low oxygen pressures and at low organic matter levels.[3,7] Before investigating the effect of high temperatures on *Azotobacter* in soils, it was considered of interest to know the effect of submitting the strains of *Azotobacter* to varying temperatures in culture solutions. The present communication deals with results of some studies carried out on heat resistance of a few strains of *Azotobacter chroococcum* isolated from different Indian soils.

The nitrogen-fixing capacities were determined in Jensen's medium[5] the incubation being carried on for two weeks at 30° C. The results are summarised in Tables I, II and III. In

TABLE I

Nitrogen-fixation by Azotobacter chroococcum *(mg./g. sucrose) from cultures frozen for different days*

(Average of duplicate determinations)

Strain	Initial	Days of freezing 2	4	6	14	35
H.P. 1 (i)	11·4	9·2	9·6	8·6	14·0	13·2
H.P. 4 (i)	11·4	12·2	14·2	11·0	11·2	12·0
H.P. 7 (i)	15·0	12·6	14·0	13·4	14·4	14·0
H.P. 9 (i)	14·0	11·2	11·0	10·2	14·6	15·2
K. 13 (iv)	15·0	10·6	12·2	11·4	13·0	15·2
K. 2 (iv)	15·6	14·8	14·4	14·8	15·4	12·4

TABLE II

Nitrogen-fixation by Azotobacter chroococcum *(mg./g. sucrose) from cultures exposed to 45° C. for different days*

(Average of duplicate determinations)

Strain	Initial	Exposure in days 2	4	6	14
H.P. 1 (i)	11·4	14·4	0·8	1·0	Nil
H.P. 4 (i)	11·4	14·2	11·8	11·6	Nil
H.P. 7 (i)	15·0	15·4	0·6	Nil	Nil
H.P. 9 (i)	14·0	14·0	15·6	Nil	Nil
K. 13 (iv)	15·0	17·4	16·6	14·8	Nil
K. 2 (iv)	15·6	17·0	14·4	12·6	Nil

TABLE III

Nitrogen-fixation by Azotobacter chroococcum *(mg./g. sucrose) in medium incubated under a diurnal variation of temperature at 25° C.*

(Average of duplicate determinations)

Strain	Initial at 30° C.	In cultures incubated at 45° C. for 5 hr. at 32° C. for 16 hr. and at 20° C. for 3 hr.
H.P. 1 (i)	11·4	9·2
H.P. 4 (i)	11·4	9·2
H.P. 7 (i)	15·0	10·8
H.P. 9 (i)	14·0	9·2
K. 13 (iv)	15·6	11·8
K. 2 (iv)	15·6	13·4

In Table I are given the nitorgen-fixing capacities of the strains of *Azotobacter chroococcum* frozen for different periods. Table II shows their nitrogen-fixing capacities after they were exposed to 45° C. for different days. Their

nitrogen-fixing capacities in Jensen's medium incubated daily at 45° C. for 5 hours, at 32° C. for 16 hours and at 20° C. for 3 hours for two weeks (simulating thus temperature conditions obtaining in summer in Northern India) are given in Table III.

The data in Tables I, II and III show that though there may be a temporary depression in the nitrogen-fixation by *Azotobacter* subjected to freezing for a short period, the general tendency was one of improvement in nitrogen-fixing capacity, notably on prolonged freezing. Its nitrogen-fixing capacity was affected adversely on prolonged exposure to 45° C. and within about two weeks of exposure the organism completely lost its power to fix nitorgen. Microscopic observations showed that it had dissociated into a coccoid form, much diminished in size. It also failed to give raised, opaque and pigmented growth; it grew into a translucent to transparent tough and beaded mass. Different strains of the organism no doubt differed in their resistance to exposure to heat; whereas some strains lost their nitrogen-fixing capacity gradually with increase in exposure to heat in others the loss occurred abruptly. It was, however, interesting to observe that though nitrogen-fixation by the organism diminished when put under a wide diurnal variation in temperature as occurring during summer days in North Indian plains, complete inhibition of nitrogen-fixation did not occur.

The authors' grateful thanks are due to Dr. B. P. Pal, Director, Indian Agricultural Research Institute, for his keen interest in the work.

Indian Agric. Res. Inst., New Delhi, *April* 21, 1958. V. Iswaran. Abhiswar Sen.

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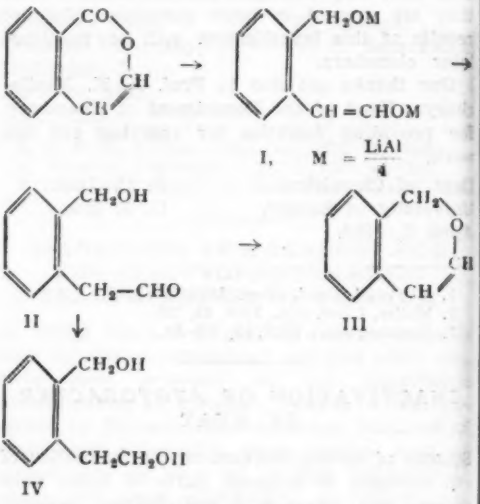
A SYNTHESIS OF *ISO*CHROMENE

Attempts to prepare isochromene (1 H-2-benzopyran) have been so far unsuccessful.[1] It transpired that the compound should be obtainable from isocoumarin according to the scheme given below and this has been carried through.



Lithium aluminium hydride (or lithium borohydride) reacts with isocoumarin in ether giving the complex (I) which was hydrolysed to o-hydroxymethylphenylacetaldehyde (II, m.p. 76°; 2 : 4-dinitrophenylhydrazone, m.p. 160°). On further reduction with lithium aluminium hydride, (II) gave the glycol (IV, di-3 : 5-dinitrobenzoate, m.p. 180°). On treatment with sodium acetate-acetic anhydride, (II) gave isochromene (III, b.p. 140°/115 mm.; m.p. 21·5°; n_D^{24} 1·5818; picrate, orange red needles, m.p. 85°) in good yield. On catalytic reduction this gave isochroman in quantitative yield. Similarly 6 : 7-dimethoxyisocoumarin[2] has been converted into 6 : 7-dimethoxyisochromene (m.p. 64°; picrate, chocolate shining needles, m.p. 103°).

The isochromenes deteriorate quickly on keeping.

Science College, Patna-5, *April* 21, 1958. J. N. Chatterjea.

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INFESTATION OF LEATHER CRUPPERS BY THE TOBACCO BEETLE *LASIODERMA SERRICORNE* FABR.

An unusual case of infestation by the tobacco beetle *Lasioderma serricorne* Fabr. of a leather store known as cruppers has been observed. The cruppers (Fig. 1) forms a part of mule

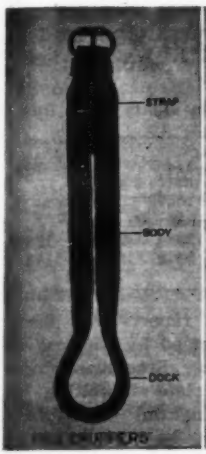

FIG. 1.

FIG. 2.

harness. It consists of a leather body, a strap and a dock. While in use the dock rests underneath the tail of the mule. In order that it remains supple and not cause irritation and injury to the mule, it is stuffed with linseed.

An examination of the infested cruppers revealed that the dock (Fig. 2) had been bored at several places by insects. Inside most of the docks were larvæ, pupæ and adults of *L. serricorne* and the linseed was found in a state of considerable damage. In others, the linseed was additionally infested with the flour beetle, *Tribolium castaneum* H., the *Khapra* beetle, *Trogoderma granarium* Everts., and the carpet beetle, *Attagenus* sp. In both the above types of infestation, it was observed that the inner surface of the docks had been burrowed at several places and in some of the burrows were present either pupæ or full-grown larvæ of *L. serricorne*. It was evident that larvæ of *L. serricorne* were responsible for the damage caused to the cruppers.

Bodkin[1] recorded for the first time the damage of leather by this insect. In the present case it appears that the linseed stuffed in the docks was initially infested with *L. serricorne* and the damage to the docks resulted from the holes made by the larvæ. Incidentally, this appears the first record of linseed being attacked by *L. serricorne*.

It has been found that the treatment of linseed with 5·0% BHC (0·65% γ-BHC) dust at the rate of 2·5 g. per kg. (0·25 lb./100 lb.) of linseed prevents infestation by *L. serricorne*. It has also been ascertained that fumigation of infested cruppers with a mixture of 3 parts of ethylene dichloride and 1 part of carbon tetrachloride (EDCT) at the rate of 560 g. per cubic metre (35 lb./1,000 c.ft.) for a period of 7 days ensures complete disinfestation. Injection of lindane dissolved in rectified spirit into the infested docks did not lead to satisfactory results.

We are grateful to the Head of the Division of Entomology, Indian Agricultural Research Institute, New Delhi, for the identification of the insect as *Lasioderma serricorne* Fabr.

Technical Development Establishment Labs., Kanpur,
March 28, 1958.

P. S. Cheema.
J. N. Misra.
S. L. Perti.
S. K. Ranganathan.

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ASCORBIC ACID IN GERMINATING SEEDS OF *SESBANIA GRANDIFLORA* PERS.

It has long been known that legumes on germination give rise to vitamin C. On the other hand, cereals, although much richer in carbohydrates, show little evidence of ascorbic acid even after long periods of germination. The question that arises is what would be the ascorbic acid levels at different stages of germination of a protein-rich seed like that of *Sesbania grandiflora*, the protein content of which was reported[1] from these laboratories to be of the order of 70%. Such a question gains, in our opinion, further relevancy in view of our recent observation that the seed contains no starch (absence of colour with iodine), and, if at all, only chromatographically detectable quantities of free sugars. However, acid hydrolysis[2] of the material freed from husk and seed-coat resulted in about 10% reducing sugars. Starch, which is totally absent to start with in the seed, begins to form after 36-42 hours' germination even in the dark, as tested by the blue colour with iodine. With the formation of starch there was no parallel increase in free reducing sugars, but the clear, water extract contained a carbohydrate (presumably sucrose) which, on mild acid hydrolysis, gave rise to free reducing sugars.

We found that *Sesbania* seeds on germination give rise to ascorbic acid in appreciable amounts, as judged by the reduction of a solution of 2 : 6-dichlorophenolindophenol and further confirmed by identical values obtained for the total ascorbic acid.[3] Typical results for the ascorbic value of *Sesbania* seedlings and comparative values for other legumes are given in Tables I and II; the latter results are close to the values generally reported in the literature for legumes.

The synthesis takes place with equal facility in the dark, under which condition there was no evidence of chlorophyll formation.

Ascorbic acid was more in the radicle than in the cotyledon. This is similar to the results reported by Shaw and Pasco[4] for the broad bean, *Vicia faba*.

Lowered temperatures (*ca.* 5°) were found to hamper germination and *ergo* biogenesis of ascorbic acid, while both were accelerated at higher temperatures (*ca.* 37°). We also found

TABLE I

Increase in ascorbic acid on germination of Sesbania *seeds (in light)*

Period of Germination Hr.	..	24	48	72	96	120	144	168	192
		Ascorbic acid mg. per 100 g. original seed							
Sesbania	..	17·3	49·2	86·0	110·7	165·6	139·4	124·6	128·0
Bengalgram (for comparison)	..	29·2	43·2	49·9	58·4	75·5	92·3	94·7	115·5

TABLE II

Ascorbic acid content of Sesbania *seedlings in comparison with other legumes germinated for the same period*

3 Sets of equal weights of seeds soaked for 12 hr. and couched in petri dishes over wet cotton wads and allowed to germinate, all in dark, at room temperature (*ca.* 25°) for 72 hr. At this stage there was no root hair, no chlorophyll in any of the materials. One set was used for determining dry weight and ascorbic acid estimated by Roe & Kuethers' method[3] in the other 2 sets.

Seed	mg. % ascorbic acid	
	On original seed weight	On dried seedling weight
(Average of closely agreeing duplicate values)		
Agati, *Sesbania grandiflora* ..	61·6	75·8
Bengalgram, *Cicer arietinum*	37·6	41·7
Blackgram, *Phaseolus mungo* ..	48·8	60·4
Cowgram, *Vigna catiang* ..	45·9	56·8
Field bean, *Dolichos lablab* ..	31·8	40·0
Greengram, *Phaseolus aureus* ..	64·7	82·4
Redgram, *Cajanus cajan* ..	42·7	48·2

Ascorbic acid in *Sesbania* seedlings at comparable ages is 40% more on the seed germinated without the husk and the seed-coat than on the whole seed. This is probably because the seed-coat is extremely hard and does not facilitate absorption of water. This result incidentally suggests that the husk and the seed-coat carbohydrates are not necessary here for the biosynthesis of ascorbic acid, which would appear to stem entirely from the seed proper.

in confirmation of previous reports that these temperature effects are reversed in the case of Bengalgram, *Cicer arietinum*. Sreenivasan and Wandrekar[5] observed complete inhibition of germination at 37° of greengram (*Phaseolus*) also, while pre-treatment in the cold and germination in the dark had beneficial influence on ascorbic acid biogenesis.

Of the effects studied of various additives to the culture medium on the synthesis of ascorbic acid with germination, seeds soaked in 0·05% citric acid solution for 12 hours and then germinated with water, gave a 40% increase in ascorbic acid, at corresponding periods, over the untreated control. Use of citric acid solution at double the concentration (0·1%) for preliminary soaking of the seed did not further increase the ascorbic acid content. Citric acid at either of the two concentrations did not affect the value in Bengalgram. The acquisition of vitamin C potency by certain seeds on soaking them for different periods in citric acid solutions has been reported by Luettmerding.[6] We did not find any beneficial effects of Mn^{++} (0·1%) on ascorbic acid synthesis in germinating *Sesbania* seeds.

It is significant that among the legumes comparatively studied, *Sesbania* seed with its low carbohydrates and high proteins shows evidence, at comparable periods of germination, of containing more ascorbic acid than any of the other legumes tried (all of them with an average carbohydrate content of 60%[7]), with the exception of greengram.

The ascorbic acid value (total) of *Sesbania* cotyledons or of the radicle immediately after

drying (40°) remains very near the value before drying. But after the dried sample had been stored for about a month at the room temperature (25-27°) in closed glass containers, it was found that the ascorbic acid content had decreased considerably, contrary to the expectation that good amounts of co-existing protein in the material would afford protection to the vitamin.

Central Food Tech. Res. Institute, Mysore, *May* 6, 1958.

S. KUPPUSWAMY.
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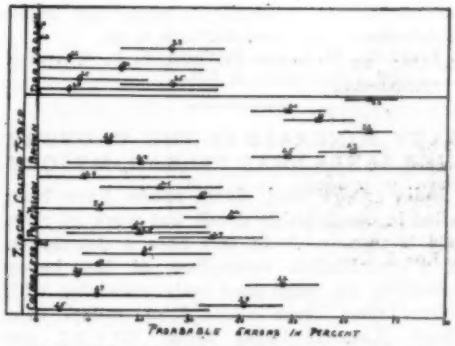
ON THE APPLICATION OF 'PROBABLE ERROR' IN THE STUDY OF ZIRCONS IN NANDI GRANITES

IN a previous note, the writer gave an account of zircons in the coarse-grained granites of Nandi, Holalkere, Chamundi and Closepet, and concluded that there is a general similarity of zircons with respect to habit, size and colour in these rocks. The present note embodies the results of the study of the Nandi granites in particular, with respect to the colour types of zircons, keeping in view of the postulate that variation within any given granite body may obscure variation between bodies.

An examination of heavy minerals separated from eight different varieties of Nandi granites, revealed that four colour types of zircons (*viz.*, colourless, pale yellow, brown and dark brown) could be easily identified and quantitatively estimated. Table I shows the frequency of zircon colour types in a total of hundred random counts per sample.

From Table I it is seen the frequency of each type of zircon is not constant for all the samples. Consequently, the question arises whether these differences could be regarded as due to pure chance alone or due to significant differences between samples. This hypothesis may be tested by using the statistic 'probable error' (Dryden). In Table I, together with the percentages of zircons, their corresponding probable error limits are given and also graphically shown in Fig. 1.



Nos. Referred in this Graph indicate Specimen Nos. given in Table I.

FIG. 1. Graphical representation of probable error limits of Zircon types in Nandi Granites.

An inspection of the table and graphical representation in Fig. 1, reveals that all the samples studied, with respect to pale yellow and dark brown types, fall within the probable

TABLE I

Frequencies of zircon colour types with their respective "probable errors" in Nandi granites

Types of zircons	(Sample Numbers)							
	N/25	N/28	N/29	N/27	N/22	N/30	N/10	N/26
	(Percentages)							
1 Colourless ..	5±29	0	40±8	12±19	48±7	8±21	12±19	21±13
2 Pale yellow ..	20±14	9±21	34±16	19±14	38±9	12±19	32±10	24±12
3 Brown ..	49±7	65±5	20±14	61±6	14±16	64±5	56±7	49±7
4 Dark Brown ..	26±10	26±10	6±28	8±21	0	16±16	0	6±29
Total No. of Counts ..	100	100	100	100	100	100	100	100

error limits of each other. But it is not so with respect to the remaining types. It may be concluded, as far as the present study discloses, that Nandi granites, despite their wide variation in lithology and texture, exhibit a general tendency for uniformity in the content of pale yellow and dark brown zircons. A similar line of approach on the study of zircons in other granite bodies in Mysore, understood to be similar in age to Nandi granites, may be of some importance in correlation and genetic studies.

The writer is grateful to Prof. M. R. Srinivasa Rao and Dr. C. Gundu Rao, Department of Geology, Central College, Bangalore, for their valuable suggestions and critical discussion throughout the preparation of this note.

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HEAVY MINERALS IN THE CAUVERY RIVER SANDS NEAR TALKAD, MYSORE

IN India, shore and dune sands have been studied in considerable detail, but work on river sands is meagre.[1,2] In this note a description and a quantitative estimation of the heavy minerals in the large sand body associated with Cauvery river (area about 5 sq. miles) near Talkad (Lat. 12° 11'N.; Long. 77° 1'E.) are given.

This sand body is pear-shaped, situated in the loop formed by the deep bend of the river. It extends for about 2 miles in a north-south direction with a maximum width of a mile-and-a-half at right angles to it. The western portion close to the river is flat-lying and the eastern, undulating due to the presence of a large number of dunes suggesting that this face of the sand body has witnessed considerable shifting by strong winds. Altogether, 14 samples were collected and each sample sieved, 5 to 10 g. of 0·25 mm. fraction passed through Bromoform; the residue quartered and mounted in Canada Balsam on glass slides to have on the average 400 to 800 grains. A microscopical examination of the slides revealed the following minerals: (1) Opaques (magnetite and ilmenite); (2) Hornblende (blue-green); (3) Chlorite; (4) Epidote; (5) Tremolite; (6) Pyroxene; (7) Garnet; (8) Kyanite; (9) Tourmaline; (10) Zircon; (11) Rutile; (12) Sphene; and (13) Apatite. Three hundred grains from each sample were counted on a random basis and the frequency of the different minerals are shown in Table I.

From this table it may be seen that the sand body, despite its fairly large size and a portion of it subjected to shifting by strong winds, shows a remarkable uniformity in heavy mineral assemblage. The significance of this uniformity could only be assessed by the study of similar sands at various points in the up and down stream directions of the river.

Detailed investigations of the several river sands in Mysore, particularly with reference

TABLE I

Frequency of the heavy minerals in the Cauvery river sands near Talkad

Sample Nos.	Hornblende	Chlorite	Garnet	Pyroxene	Kyanite	Tourmaline	Opaques	Tremolite	Apatite	Epidote	Rutile	Zircon	Sphene	Unknowns
$3/A_1$ ..	10	11	5	2	7	6	39	5	1	9	2	1	1	1
$3/A_2$ ..	13	11	7	4	5	8	28	10	..	11	1	..	..	2
$3/A_3$ ..	15	9	5	5	5	6	27	10	1	12	2	2	1	..
$3/A_4$ ..	10	8	10	10	8	5	24	12	2	6	2	1	..	2
$3/B_2$ ..	16	17	5	5	11	7	10	10	3	14	..	..	..	2
$3/B_3$ ..	19	15	6	6	10	7	19	6	2	7	2	..	..	1
$3/B_5$ ..	12	11	8	2	11	11	18	11	..	10	3	..	..	3
$3/C_1$ ..	21	12	8	6	7	6	22	5	2	11	1	1	..	..
$3/C_2$ ..	25	14	7	6	7	9	9	10	4	6	..	..	..	3
$3/C_3$ ..	16	10	4	5	4	7	23	13	1	13	2	·5	·5	1
$3/C_4$ ..	19	17	4	8	7	6	20	8	3	6	2	..	..	..
$3/D_1$ ..	22	13	7	5	7	7	14	10	2	9	1	1	..	2
$3/D_2$ ..	13	12	5	2	9	11	24	8	5	7	1	1	1	1
$3/D_3$ ..	17	14	6	7	7	7	19	9	2	11	..	1	..	..

to their various sedimentological and economic aspects are under progress.

I am indebted to Professor M. R. Srinivasa Rao and Dr. C. Gundu Rao for their guidance and helpful suggestions in the preparation of this note.

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OCCURRENCE OF MONAZITE IN THE CHARNOCKITES OF VISAKHAPATNAM

MONAZITE was reported in the beach sands of Visakhapatnam Coast by Mahadevan and Sriramadas[1] and the source for the monazite in the beach sands was traced to the alluvium in the streams flowing in towards the beach and thence to the pegmatites in the area by Mahadevan and Sathapathi.[2] In Padmanabham village, 25 miles north of this area, Srinivasa Sastry[3] reported the occurrence of monazite in the leptynites. The present work shows the existence of monazite not only in the pegmatites and leptynites but also in charnockites.

FIG. 1. Monazite (inside the circle) from Acid Charnockite. Magnification, × 45.

The Visakhapatnam area located in between Lat. 17° 42′ and 17° 45′ N. and Long. 83° 17′ and 83° 21′ 15″ E. consists of khondalites, leptynites, charnockites, granites, pegmatites and quartzites in the order of abundance. In the detailed study of thin sections, monazite was noticed in the acid charnockite, intermediate charnockite, leptynite and pegmatite. The acid charnockite consists of quartz, perthite, oligoclase, hypersthene, magnetite, zircon and monazite. Monazite in contact with magnetite is found as an inclusion in oligoclase. The monazite grain is oval in outline and has dark border due to high refractive index. The garnetiferous acid charnockite contains garnet in addition to the above constituents. The intermediate charnockite contains quartz, perthite, andesine, hypersthene, diopside, biotite, magnetite, apatite and monazite. The leptynite has quartz, perthite, plagioclase, garnet and monazite as its constituents. The pegmatite consists of quartz, perthite, biotite, zircon and monazite.

The modal compositions of acid and intermediate charnockites and leptynite were determined and given in Table I.

TABLE I
Modal composition

	I	II	III	IV	V
Quartz ..	27·84	26·71	39·86	6·50	40·94
Perthite ..	49·56	39·69	27·85	5·67	42·84
Plagioclase ..	12·08	21·15	19·16	39·73	11·31
Hypersthene ..	2·13	6·48	9·34	12·38	..
Diopside ..	..	..	..	27·15	..
Garnet ..	3·97	..	..	..	4·53
Biotite ..	..	..	..	1·78	0·05
Magnetite ..	3·60	5·71	3·66	6·59	0·28
Apatite ..	0·48	..	0·13	0·17	..
Zircon ..	0·23	0·18	..	..	..
Monazite ..	0·11	0·08	<0·05	<0·05	0·06

I—Garnetiferous acid charnockite from Visakhapatnam area (Lat. 17° 43′ 15″–Long. 83° 20′).
II—Acid charnockite from Visakhapatnam area (Lat. 17° 43′ 15″–Long. 83° 20′).
III—Fine-grained acid charnockite from Visakhapatnam area (Lat. 17° 44′–Long. 83° 19′ 15″).
IV—Intermediate charnockite from Visakhapatnam area (Lat. 17° 44′–Long. 83° 19′ 15″).
V—Leptynite from Visakhapatnam area (Lat. 17° 44′–Long. 83° 19′ 15″).

The modal analysis shows that the monazite is 0·08% in acid charnockite, 0·11% in garnetiferous acid charnockite and < 0·05% in fine-grained acid and intermediate charnockites. Leptynite contains 0·05% of monazite. The grain size of the monazite in these rocks varies from 0·04 mm. to 0·21 mm.

Pyroxenes are separated from the other minerals of the charnockites by Frantz Isodynamic separator. They are examined under the microscope to see whether they are free from other minerals. The examination disclosed

monazite along with the pyroxene in the magnetic fraction.

Monazite is usually found in association with zircon. The oval shape, yellowish colour, shining dark borders, high interference colours and biaxial nature of monazite distinguished it from zircon which was found with prismatic faces or prism with pyramidal faces. Another important factor in distinguishing monazite from zircon is that monazite is paramagnetic whereas zircon is diamagnetic.

Among the 40 sections examined, monazite is found more in garnetiferous acid charnockite than the rest of the rocks. Monazite in the intermediate charnockite is less than in the acid charnockite. Monazite from leptynites and pegmatites is also less than in the acid charnockites.

Monazite is associated with quartz and perthite-rich rocks. Among the charnockites, perthitic felspar is abundant in the acid charnockite. In the intermediate charnockite, perthitic felspar is very much less as is the case with monazite. In the basic charnockite both perthite and monazite were not found. So the formation of monazite was facilitated more in the acid charnockites. This observation is supported by the geochemistry of thorium (Goldschmidt[4]).

The large ionic radius of thorium in monazite makes it unfit to enter many of the important orthosilicates or metasilicates of magnesium and divalent iron. So thorium is generally found concentrated in the residual magmas. In the present case the association of monazite with the acid charnockites agrees with this expectation of finding monazite in the residual magmas. Although it is seen in the intermediate charnockites, it is much less abundant showing that the acidity was not enough for the formation of more monazite at that stage.

The author is very much grateful to Dr. A. Sriramadas for his guidance and valuable suggestions, and to Prof. C. Mahadevan for his kind interest. The author also wishes to express his thanks to the Government of India for the award of scholarship.

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ON A NEW SPECIES OF *PROCAMALLANUS* BAYLIS, 1923 (NEMATODA)

FIVE specimens of *Heteropneustes fossilis* (Day), obtained from local market and examined by me on 20th December, 1957, at Allahabad yielded from their alimentary canal 12 female and 4 male specimens of a new species of the genus *Procamallanus*. The new species is described here under the name *Procamallanus spiculogubernaculus*.

DESCRIPTION OF *Procamallanus spiculogubernaculus* n. sp.

(The measurements given are in millimetres.)

Holotype Male.—Body: $3{\cdot}68 \times 0{\cdot}088$, buccal capsule $0{\cdot}06 \times 0{\cdot}036$, anterior œsophagus $0{\cdot}24 \times 0{\cdot}044$, posterior œsophagus $0{\cdot}3 \times 0{\cdot}036$. Nerve ring at 0·12 from anterior end of the body. Tail blunt and conical. Caudal papillæ seven pairs: four pairs pre-cloacal and three pairs post-cloacal. Spicules two, the right long spicule 0·344 long, the left small spicule 0·05 long. Gubernaculum 0·05 long and incompletely fused with the right smaller spicule. Caudal alæ absent.

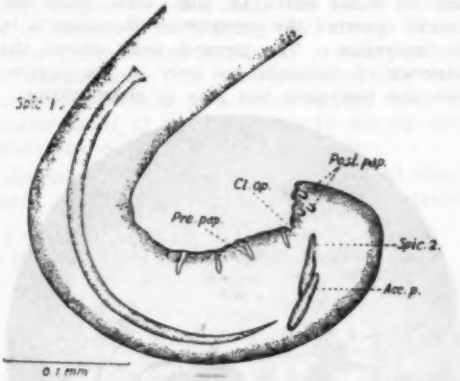

FIG. 1. *Procamallanus spiculogubernaculus*. Tail of male showing important characters. *Acc. p.*, accessory piece; *Cl. op.*, cloacal opening; *Pre. pap.*, pre-cloacal papillæ; *Post. pap.*, post-cloacal papillæ; *Spic.* 1, longer spicule; *Spic.* 2, smaller spicule.

Holotype Female.—Body $4{\cdot}84 \times 0{\cdot}088$, buccal capsule $0{\cdot}08 \times 0{\cdot}048$, anterior œsophagus $0{\cdot}32 \times 0{\cdot}06$, posterior œsophagus $0{\cdot}46 \times 0{\cdot}048$, rectum 0·05 long. Nerve ring at 0·142 and small excretory pore at 0·232 from anterior end of the body. Tail 0·1 long, tapering, pointed, bifid at the tip. Vulva post-equatorial, 2·64 from the anterior end of the body and forming a marked elevation of the body. Vagina 0·608 long.

Important characters of Procamallanus spiculogubernaculus.—Gubernaculum incompletely fused with the smaller spicule; caudal papillæ 4 + 3 = 7 pairs; vulva post-equatorial; female tail terminally bifid; buccal capsule chitinoid, elongated, barrel-shaped, smooth and undivided; rim of buccal capsule has three lip-like protuberances; caudal and cervical alæ absent; body-size small.

P. spiculogubernaculus differs from *P. glossogobii*[4] chiefly in the incomplete fusion of one spicule with the gubernaculum, the caudal papillæ and the position of vulva; from *P. bagarii*[1] chiefly in the fusion of one spicule with the glubernaculum and the structure of buccal capsule; from *P. fulvidraconis*[3] chiefly in the presence of gubernaculum and the structure of buccal capsule; from *P. cearensis*[5] chiefly in its unequal spicules and the structure of buccal capsule; from *P. gubernaculus*[2] chiefly in the number of spicules, the fusion of gubernaculum with one spicule, the number of caudal papillæ and the structure of buccal capsule. From other species of the genus the new species differs very widely, the unique character of the form being the incomplete fusion of right small spicule with gubernaculum.

I am grateful to Dr. S. Khera, D.S.B. Govt. College, Naini Tal, for going through the manuscript.

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DREDGING AND PHYTOPLANKTON PRODUCTION

IT is well known from the investigations of various workers[6–11] that the bottom mud in the sea is rich in regenerated nutrients which are essential raw materials for phytoplankton production. The natural agencies concerned in bringing these nutrients to the surface waters, where photosynthesis takes place, are the different kinds of water movements such as turbulence, upwelling and so on. In fresh-water ponds, where piscicultural operations are carried out, it is a common practice to periodically rake the bottom mud to stimulate plankton production. In the present instance it is interesting that the churning up of the bottom muds is brought about through an artificial agency, namely, dredging.

While engaged in investigations on the phytoplankton production off Waltair Coast, in 1957, we observed some unusual pulses in the density of phytoplankton populations during periods when normally they are scarce. These pulses appeared sporadically and disappeared as suddenly as they appeared. Previous workers[2,3] from this department have established that off this coast there is a major phytoplankton peak in the March-April period and a minor peak in the months of October and November. The unusual pulses referred to were observed in the month of July when normally the phytoplankton numbers are very low as judged from the data for the previous years. It was also observed that these pulses immediately followed an extensive discolouration of the inshore waters owing to the discharge of large quantities of dredged material near the entrance channel of the Harbour.

The samples of water and plankton were collected from a fixed location in the Lawson's Bay, which is about 5 miles from the entrance channel of the Harbour. Standard techniques were adopted for the estimation of phosphates[12] and silicates.[13] The phytoplankton production was measured by adopting the pigment extraction method of Harvey[5] and also by measuring the photosynthetic activity using Gran's method.[4] The turbidity was measured with a Hellige Turbidometer. For comparison, the data for the same month in 1956 have also been given in the table as well as in the graph.

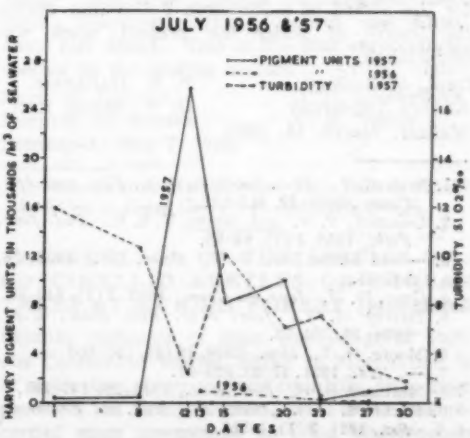

FIG. 1

TABLE I

July Dates	Turbidity SiO_2 ‰	Inorganic phosphates μg. at/L.		Silicates μg. at/L.		Pigments H.U./M^3 S. W.		Photosynthesis O_2ml./L./6 hrs. exposure
	1957	1956	1957	1956	1957	1956	1957	1957
1	15·90	..	1·20	..	16·20	..	403·75	0·488
5	..	0·87	..	12·8	..	..	..	..
8	12·70	..	0·31	..	20·90	..	415·63	0·471
12	2·35	..	0·53	..	20·31	..	2562·0	1·866
13	..	..	..	..	..	975·0	..	..
15	12·10	..	1·61	..	20·90	..	4156·25	0·586
19	..	0·74	..	11·8	..	..	..	..
20	6·20	..	1·73	..	23·70	..	10000·0	0·693
23	7·10	0·75	1·78	12·4	15·90	178·75	195·50	0·441
27	2·85	0·74	2·36	8·84	18·10	84·37	948·75	0·499
30	1·70	0·73	0·40	12·3	7·50	..	1128·75	0·499

* Data on turbidity and photosynthesis are not available for July, 1956.

It will be seen from the data presented that the two steep rises in pigment values are on dates immediately following the days when the water was highly turbid. The turbidity in its turn was proportional to the amount of dredged material hoppered into the sea. The photosynthetic activity as measured by oxygen production[4] had also a close correlation with the density of the phytoplankton.

Detailed investigations on the chemical composition of the dredged mud and its probable influence on the productivity of plankton are being continued.

It gives us great pleasure to extend our grateful thanks to Sri. P. V. Appa Rao, A.E.D., Vizag Port, and the officers of S.D. "Vizagapatnam" for evincing keen interest in the work and for affording facilities in collecting our data. One of us (D. V. S.) is also indebted to the C.S.I.R. for the award of a Research Fellowship during the tenure of which the present work was undertaken.

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NEUROSECRETORY CELLS OF THE BRAIN OF THE LEECH *HIRUDINARIA GRANULOSA* (SAV.)

WHILE considerable information is available on the neurosecretory cells and their physiology in Arthropoda and Vertebrata, comparatively very little is known about those of Annelida. The few Annelidan forms that have been investigated are mainly Polychæta[1–3]; so far only one work refers to the presence of neurosecretory cells in the leech *Hirudo medicinalis*.[4] The present investigation was started with a view to study the structure and functions of the neurosecretory cells of the Indian cattle leech *Hirudinaria granulosa* (Sav.).

Sections of the cerebral ganglia, stained in Gomori's chrome alum-hæmatoxylin-phloxine, reveal the presence of distinctive types of neurosecretory cells in the brain of the leech. Of these, a large number belongs to a type of cells characterised by the abundance of vacuoles in the cytoplasm and scattered clumps of colloids stained blue (Fig. 1). These cells lie on the dorsal surface of the cerebral ganglia and measure about 53·39 μ in diameter, with large nuclei measuring about 11·65 μ in diameter and strongly phloxinophilic nucleoli. These cells

may be compared to the large "C" type of cells described by Clark[2] in the Polychæte *Nephthys*.

A second type of fewer, comparatively smaller cells, measuring about 30-98 μ in diameter, with the cytoplasm uniformly filled with blue granules and distinctive axonic pathways, are also seen on the dorsolateral borders of the brain. These cells show no vacuoles. Two or three cells laterally, however, show a phloxinophilic cytoplasm.

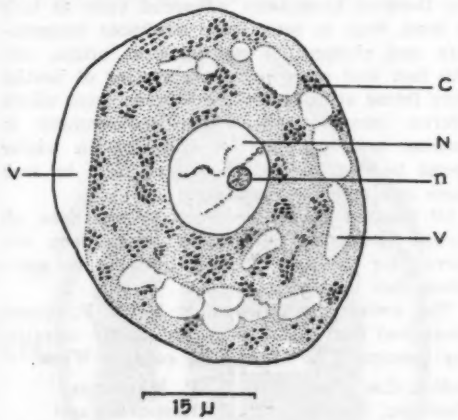

FIG. 1. Camera lucida drawing of a vacuolated type of neurosecretory cell from the brain of *Hirudinaria granulosa* (Sav.). Fixation: Bouin + Gomori's chrome alum-hæmatoxylin-phloxine. C = colloids; N = nucleus; *n* = nucleolus; V = vacuole.

An accumulation of blue colloids and granules is seen on the dorsal, outer periphery of the brain, where the latter lies contiguous with the ventral hæmocœlomic channel investing the nerve ring. This abundance of stainable material suggests a possible release of the neurosecretory colloids into the hæmocœlomic fluid. Such a condition is especially well marked in leeches which have been starving for a few weeks.

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OCCURRENCE OF *PARAPENAEOPSIS CORNUTUS* KISHINOUYE IN THE SEAS OF INDIA

IN July 1957, while making a routine collection of *Metapenæus monoceros* from Mahim, Bombay, a few specimens of *P. cornutus* were found mixed with those of *P. maxillipedo* in the catch of a drag net. *P. cornutus* is very much allied to *P. maxillipedo* but differs from it, in the absence of a basial spine on the third periopod of the female and in the possession of a typically boot-shaped endopodite on the second pleopod of the male.

The specimens range in size from 40-60 mm. The rostrum is sigmoid and dorsally armed with 6-7 teeth. Branchiocardiac sulcus present in both the sexes. Telson unarmed. Cardiac plate with 28-29 spinules. Zygocardiac ossicle with 5 teeth in the upper row, leading to a cluster of smaller teeth. The thelycum consists of a subrectangular anterior plate, covered with setæ on the distal half of the ventral surface and a posterior plate, which is bifid anteriorly. The distal projections of the petasma are long and slender. In male, the endopodite of the second pleopod is typically boot-shaped and is provided with a number of small setæ on the distal margin. In fresh condition, the body is faintly bluish with transverse brown straps on the abdomen. Uropods are purple red.

The species seems to be uncommon. The present description essentially agrees with the description of Dall (1957) and the important differences between the present description and the description of Kubo (1949) are of the gastric armature only.

Previously recorded in Australia (Dall), Japan (Kishinouye, Osada, Tanizaki and Nakazawa), Formosa (Maki, Tuchiya and Kubo), Java (De Man). This is the first record of the species in the Indian waters.

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ASSEMBLAGE OF TEN SPECIES OF COCCINELLID BEETLES ON BANYAN TREES AT KUNDRI FOREST IN BIHAR

SEVERAL instances of mass assemblage of various Coccinellid beetles, either in hibernation or in æstivation, from various countries have been reported. In India, Kapur (1943, 1954) has recorded mass assemblage of *Thea bisoctonotata* Muls. at Lahore, and *Epilachna bisquadri-*

punctata (Gyllenhal) in Chotanagpur. Mani (1954) observed *Coccinella septumpunctata* L. at glacier beds of Lakka pass in Western Himalayas. Rao and others (1954) cite an instance of æstivation in large numbers of *Chilocorus nigritus* F. on Banyan (*Ficus bengalensis*) trees in Madras State.

The writers also observed a similar instance of an assemblage on a large scale of ten species of predaceous Coccinellid beetles on Banyan (*Ficus bengalensis*) trees at Kundri forest in Palamu Forest Division, Chotanagpur. This forest is almost a pure patch of naturally-occurring *palas* (*Butea monosperma*) trees numbering over forty thousand and is exploited for lac cultivation by the Indian Lac Research Institute. In addition to *palas* trees, a few other species of trees including some *Ficus* sp. also occur. The area is one of the hottest places in Bihar and the maximum temperature in summer goes up to 115-20° F.

Observations made between April and July in the years 1956 and 1957, indicated that this phenomenon was exhibited by 10 species of predaceous Coccinellid beetles and the beetles were invariably found on the Banyan trees on the under-surface of leaves and on the fruits. The Banyan trees were free from any kind of insect infestation and there was no food attraction for such an assemblage.

The species recorded in the order of abundance are the following:—

1. *Chilocorus nigritus* (F.).
2. *Cœlophora cardoni* Weise.
3. *Thea cincta* (F.).
4. *Pharoscymnus flexibilis* Muls.
5. *Scymnus nubilus* Muls.
6. *Scymnus coccivora* Ramakrishna.
7. *Catana parcesetosa* Sicard.
8. *Menochilus sexmaculata* Fabr.
9. *Synia melanaria* var. *rougeti* Muls.
10. *Stethorous gilvifrons* Muls.

The first-mentioned species was the most abundant of all and was observed in many hundred clusters, each cluster containing from 15-40 beetles. With the advent of the monsoons the beetles disappeared from the Banyan trees.

Observations made in January-February 1958, showed that five of the ten species mentioned above had congregated on the Banyan trees. In this season, however, the clusters and individuals per cluster were comparatively fewer in number, as indicated below in the collections made from lower branches of nine Banyan trees present in the area.

1. *Chilocorus nigritus* (F.) (271).
2. *Cœlophora cardoni* Weise (76).
3. *Menochilus sexmaculata* F. (14).
4. *Thea cincta* (F.) (2).
5. *Synia melanaria* Muls. (1).

The number per cluster ranged between 2-16. It was also noted that there was a definite tendency on the part of the beetles to get under protected situations such as, in between two leaves webbed together by spiders or within curled leaves.

As an explanation of this phenomenon, various theories have been advanced such as lack of food, urge to seek more equitable temperature and changes of physiological origin, etc. The fact that more than one species of beetles were found attracted to the Banyan trees which offered comparatively cooler environment in summer and less cold environment in winter seems to support the theory of urge to seek more equitable temperature.

Of the ten species recorded in this note, all except *Chilocorus nigritus* F. have been observed for the first time in India to be exhibiting this phenomenon.

The writers are indebted to Dr. A. P. Kapur, Zoological Survey of India, for kindly identifying specimens of *Cœlophora cardoni* Weise.

Indian Lac. Res. Inst., Namkum, Ranchi, Bihar, *March* 22, 1958.

C. P. Malhotra.
S. Krishnaswami.

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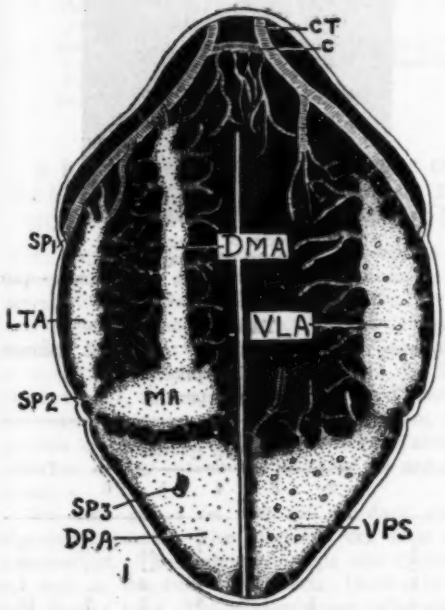
RESPIRATORY SYSTEM OF THE QUEEN OF *FORMICA FUSCA* L.

The queens of Formicoidea dispose of their wings and generally these deälated individuals use their fat body and the product of histolysis of the large wing muscles as food. The present note deals with the changes in the respiratory system as a consequence of the degeneration of flight muscles in *Formica fusca* L. The following interesting observations were made while engaged in the study of the respiratory system of Hymenoptera. It may be mentioned here that it takes over 2-3 weeks for the partial degeneration of the muscles. Briefly, the system of tracheæ and air-sacs in the thorax of the alated queen is as follows. The cervical tracheæ on entering the prothorax are connected by a transverse tracheal commissure. There are lateral air-sacs in the mesothorax. These extend dorsally in the meso-

scutellum forming paired mesoscutellar sacs. The paired mesoscutellar sacs proceed to the anterior side giving rise to the dorsal muscular sacs. In the propodeum (epinotum) the lateral sacs again extend dorsally and form a single dorsal propodeal sac. Ventrally there are ventro-lateral sacs in the thorax and paired ventral propodeal sacs in the propodeum. Short tracheæ connect the lateral sacs and dorsal propodeal sacs to the second thoracic and propodeal spiracles respectively (Fig. 1).

(epinotum). In the cephalic region the air-sacs are all more enlarged and more tubular connectives occur between the various relevant sacs. In the abdomen there are a few variations. The above findings clearly suggest some post-metamorphic changes in the tracheal system connected with the degeneration of thoracic musculature. Janet (1902, 1907) has noted a similar phenomenon in *Lasius niger* Linn.

A full account of these observations will be published elsewhere.



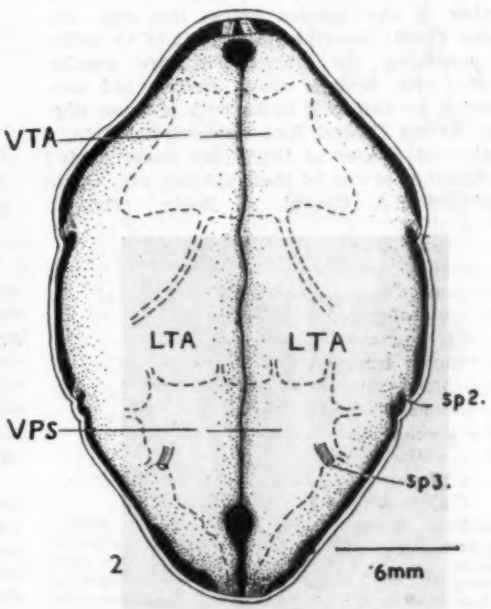


FIG. 1. Dorsal view of the air-sacs in the thorax of the winged queen of *Formica fusca* L. SP_1–SP_3 = Spiracle and spiracular trachea; CT = Cervical trachea; C = Transverse Commissure; LTA = Lateral thoracic air-sac; DMA = Dorsal muscular air-sac; MA = Mesoscutellar air-sac; DPA = Dorsal propodeal air-sac; VPS = Ventral propodeal air-sac; VLA = Ventro-lateral air-sac.

FIG. 2. Dorsal view of the air-sacs in the thorax of the dealated queen of *Formica fusca* L. LTA = Lateral thoracic air sac; SP_1–SP_3 = Spiracle and spiracular trachea; VTA = Ventral thoracic air-sac; VPS = Ventral propodeal air-sac.

But in the thorax of the dealated queens, there are only a few degenerated muscle fibres dorsally and ventrally and almost the entire space is occupied by two enormous sacs (Fig. 2). The two sacs are connected in the anterior part of the thorax. Spiracular tracheæ are very short. These two lateral thoracic sacs are connected with a median anterior ventral thoracic sac near the first phragma—as well as the ventral posterior thoracic sac in the propodeum

M.A.C.S. Laboratory,
Law College Buildings,
Poona-4, *May* 27, 1958.

G. T. TONAPI.

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VARIATION IN THE STAMEN NUMBER IN *ORYZA BRACHYANTHA* A. CHEVAL. *ET* ROEHR. AND THE FREQUENCY OF OCCURRENCE OF 3-STYLED GYNAECEA IN *O. GRANDIGLUMIS* PRODOEHL.

THE genus *Oryza* belongs to the tribe *Oryzæ* of the natural order Graminæ. This genus, according to Chatterjee (1948), is characterised by the possession of six stamens. Chatterjee *loc. cit.* has described 23 species of *Oryza*, but nowhere has he mentioned about the stamen number of any species being less than six. Hector (1936) describes the florets of *O. sativa* as possessing six stamens in two regular whorls, with central ovary smooth and surmounted by two long styles with plumose stigmas. At the Central Rice Research Institute, a number of species of *Oryza* are under study; examination of one of these species, *viz.*, *Oryza brachyantha* A. Cheval. *et.* Roehr. (Fig. 1)

FIG. 1. *O. brachyantha* in bloom.

showed the presence of a varying number of stamens, in different spikelets on the same panicle. The stamen number varied from 2-6 per spikelet, with 46·8% of the spikelets possessing 4 stamens each and 40·2% having 5 stamens each (Fig. 2). Two and three stamens per spikelet occurred occasionally, while six occurred rarely. Ten random panicles were examined; results are presented in Table I.

In plants, the presence of a large number of free stamens is considered a primitive character, while its reduction in number or uniting together is considered an advanced character. Thus the reduction in the number of stamens in *O. brachyantha* from the normal six to five and less may be regarded as a step towards advancement in the process of evolution.

FIG. 2. Panicles of *O. brachyantha*.
Left: Spikelet with four stamens.
Right: Spikelet with five stamens—four visible, one covered up.

TABLE I

Frequency of occurrence of different stamen numbers in the spikelets of Oryza brachyantha

Panicles No.	Stamens per spikelet					Total
	2	3	4	5	6	
1	1	1	1	..	..	3
2	..	1	2	..	..	3
3	..	2	1	4	..	7
4	1	..	5	3	1	10
5	1	1	1	1	..	4
6	..	1	4	6	..	11
7	..	..	5	5	..	10
8	..	..	4	5	..	9
9	..	..	6	3	..	9
10	..	..	7	4	..	11
Total ..	3	6	36	31	1	77
Percentage on Total	3·9	7·8	46·8	40·2	1·3	100·00

Occurrence of two and three styles in different spikelets of the panicle in *O. grandiglumis* Prodoehl., has been reported by Chandrasekharan *et al.* (1950), while that in *Oryza sativa* has been reported by Ray (1951) and Ghose and Butany (1952). Spikelets from several panicles of *O. grandiglumis* were examined and it was found that of the 907 spikelets examined, 596 (65·7%) had three-styled stigmas while 311 (34·3%) had two-styled stigmas.

Plants raised separately from three-styled and two-styled spikelets, did not breed true for the style number, but once again produced plants with two and three-styled spikelets in the same panicle.

Central Rice Res. Inst., W. T. BUTANY.
Cuttack, *April* 5, 1958.

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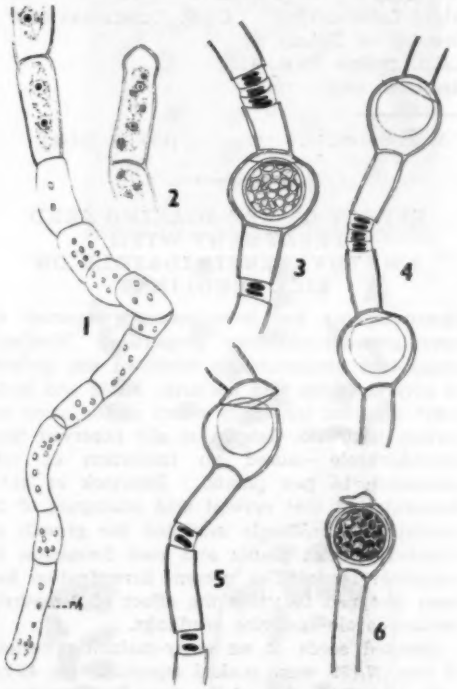
A NEW TERRESTRIAL SPECIES OF *OEDOGONIUM* (*Oe. RANDHAWAE* SP. NOV.) FROM WEST BENGAL, INDIA

THE genus *Oedogonium* was considered as aquatic till in 1939, Randhawa described a terrestrial species of *Oedogonium*, *Oe. terrestris* from Fyzabad District, Uttar Pradesh, India.[1] This was the first and only record of a terrestrial species of *Oedogonium*. In September 1957, the same author collected another terrestrial species of *Oedogonium* from the garden of Agri-Horticultural Society, Calcutta, and has kindly placed the material at my disposal.

The alga grows on wet soil in dark green circular patches. The filaments are long and unbranched. The vegetative cells are cylindrical and in the sub-aerial parts 14-16 μ broad and 28-40 μ long. The subterranean cells which serve the function of the rhizoids are hyaline, and elongated. The apical cell is obtuse.

This species is monœcious and the oogonium is usually single, intercalary and rarely terminal, subglobose to pyriform in shape (Figs. 3-6). Oogonia are 24-36 μ broad, 32-36 μ long, operculate and the opening is by means of a superior operculum. The oospores are globose, 28 μ in diameter, pale brown in colour, partially fill the oogonium, and the spore-wall is reticulate (Figs. 3 and 6). The antheridia are sub-epigynous as well as sub-hypogynous, 12-14 μ broad and 3·8-7·6 μ long, 1-4 in number, and each antheridium produces two sperms by a horizontal division (Figs. 3-5).

The only related species is *Oe. terrestris* Randh. which the present alga resembles in its monœcious nature and terrestrial habitat, but from which it differs in its reticulate spore-wall and the antheridium producing two sperms. This species differs from the other known species of *Oedogonium* in its terrestrial habitat and reticulate spore-wall.



FIGS. 1–6. *Oedogonium randhawæ* sp. nov. Fig. 1. Part of a filament showing sub-aerial and subterranean portions; Fig. 2. A terminal cell; Figs. 3–5. A filament showing oogonia and antheridia; Fig. 6. A terminal oogonium. (Note the opening by the lid in Figs. 5 and 6, and the reticulate spore-wall in Figs. 3 and 6. (Figs. 1–6, × 860.) (*rh* = rhizoid.)

Oedogonium randhawæ *sp. nov.*—Monoicum; terrestris; oogoniis singulis, intercalaris (rarius terminalis), oogoniis subglobosis vel pyriformibus, operculo apertis, circumscissione superiore; oosporis globosis, oogonia non-complentibus, mesosporia reticulatus, pallide fusco; antheridiis subepigynis vel subhypogynis, gametis masculis binis, divisione horizontali ortis, 1-3 continuis; cellula terminali apice obtuse; cellula basali forma, ut vulgo, elongata; cellulis vegetativis 14-16 × 28-40 μ; oogoniis 24-36 × 32-36 μ; oosporis 28 μ latis; antheridiis 12-14 × 3·8-7·6 μ.

Habitat.—Growing on wet soil in the garden of Agri-Horticultural Society, Alipore Road, Calcutta, Bengal, India, September 20, 1957.

I am highly grateful to Dr. M. S. Randhawa

for his kindness in placing the material at my disposal. My sincere thanks are also due to Dr. B. P. Pal and Dr. S. M. Sikka for kindly providing the facilities for work.

Algal Laboratory, G. S. VENKATARAMAN.
Division of Botany,
I.A.R.I., New Delhi-12,
April 30, 1958.

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EFFECT OF PRE-SOAKING SEED TREATMENT WITH 2-METHYLBENZIMIDAZOLE ON RICE SEEDLINGS

BENZIMIDAZOLE has been recently reported to have growth inhibitory properties. Woolley[1] noted that benzimidazole inhibited the growth of several yeasts and bacteria. Klotz and Mellody[2] reported inhibitory effect of the same on certain bacteria. Galston *et al.*[3] observed that benzimidazole caused an inhibition of cell elongation in pea plants. Rebstock *et al.*[4,5] demonstrated that several acid analogues of 2-mercaptobenzimidazole inhibited the growth of Cranberry bean plants and root formation in cucumber seeds. The present investigation has been designed to study the effect of 2-methylbenzimidazole[6] on rice seedlings.

Selected seeds of an early-maturing variety of rice, N.136, were soaked separately for 48 hr. with 10 c.c. of each of the four concentrations, 1, 10, 100, and 1,000 parts per million (p.p.m.) of 2-methylbenzimidazole. Another series soaked simply in distilled water was maintained as controls. The seeds were next thoroughly washed in running water and were sown in seed pots containing sawdust at the rate of 100 seeds per pot. Each treatment had three replications.

The results are presented in Table I and they bring out the following points.

1. The chemical induces a significant stimulating effect on the length of root and shoot as well as on their fresh weight at the two lower concentrations of 1 and 10 p.p.m. over those of the controls. The relative effectiveness of 1 and 10 p.p.m. appear almost to be the same.

2. On the other hand, just an opposite effect of inhibition which is statistically significant is observed in all these characteristics at the two higher concentrations of 100 and 1,000 p.p.m., more conspicuous effects being marked in the highest concentration. As between the effects on root growth and shoot growth it is seen that there is not much difference at the concentration of 100 p.p.m. but at the highest concentration of 1,000 p.p.m. the inhibition in root growth is more pronounced than shoot growth.

TABLE I

Effect of 2-methylbenzimidazole on length of root and shoot and number of roots
(Soaking date: 8-1-1958)
(Each figure is an average of 9 seedlings)

Days from soaking	Concentration in p.p.m. 0	1	10	100	1000	S.E. Mean and C.D. at 5% for treatment concentration
Total length of all roots per seedling in mm.						
7	12·1	13·0	10·8	8·2	7·0	..
12	30·0	38·2	34·7	22·2	18·0	1·62
16	50·3	50·2	55·4	25·0	18·9	3·33
20	80·7	82·6	81·6	62·1	23·1	..
25	93·6	95·5	100·0	78·1	28·5	..
Length of shoot per seedling in mm.						
7	15·1	18·7	17·3	12·6	6·0	..
12	42·7	50·8	47·2	41·0	38·3	1·03
16	60·6	63·7	61·8	46·6	42·9	2·92
20	84·7	98·0	95·8	79·1	72·9	..
25	112·3	116·5	118·3	89·8	87·2	..
Number of roots per seedling						
7	..	..	..	..	..	..
12	3·1	3·2	3·2	2·7	2·3	0·12
16	4·1	3·7	3·8	3·1	2·6	0·45
20	4·1	3·9	4·2	3·2	2·7	..
25	4·6	4·3	4·7	4·1	3·0	..

Thus as has been observed in case of some auxins,[7] the growth responses to 2-methylbenzimidazole show a two-phase concentration curve with promotive effects at low concentrations and inhibitory effects at high concentrations.

We are thankful to Dr. M. K. Rout, Sri. B. K. Patnaik and to Sri. P. K. Misra of the Chemistry Department of this College, for kindly synthesizing and supplying us the chemical.

Department of Botany, G. MISRA.
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CYTOLOGY OF TWO SPECIES OF SALVINIACEÆ

IN recent years the cytology of most of the homosporous fern genera has been studied. Although we know a fairly good deal regarding the morphology of the heterosporous members of the Filicales, practically nothing is known of their cytology, an aspect which may prove helpful in deducing the phyletic affinities of these ferns. In view of this, it was considered worthwhile to work out the available members of this group of plants.

Mehra and Loyal[8] reported the chromosome number of *Marsilea minuta* from Punjab plains. The present report intends to record the cytological observations on *Azolla pinnata* R. Brown and *Salvinia natans* All. following the usual acetocarmine squash technique. The course of meiosis is normal in both, resulting in the formation of seemingly viable mega- and microspores.

Azolla pinnata is widely distributed and according to Baker[2] the variety *africana* is known from tropical Africa, Asia, Japan and Madagascar. In the Punjab the species grows profusely in ponds and ditches as long as water is available. Generally the spore formation occurs from October to April. In a number of preparations 22 bivalents are counted at diakinesis within the microspore-mother-cells (Fig. 1 and Explanatory Fig. 2). Earlier Litardiere[5] reported $2n = 48$ in *Azolla carolineana* but his observations were based upon sectioned material which experience has shown may not be trustworthy. The size of the chromosomes in this species is very small, perhaps the smallest amongst the ferns.

S. natans was collected from Dal Lake and other streams in Srinagar (Kashmir) in September 1957, where it grows prolifically as a weed. Avanzie-DÀmato[1] reported $2n = 18$ in the material of *S. natans* collected from Pisa (Italy). Cytologically the Kashmir material resembles the Italian one and shows 9 bivalents in several spore mother-cells (Fig. 3). This number has been confirmed at A_1 (Fig. 4). The somatic number determined from tapetal cells is clearly 18 (Fig. 5). The chromosomes are somewhat larger than those of *Azolla pinnata*.

Bower[3] and Copeland[4] suggested on morphological evidence that the family Salviniaceæ is related to Hymenophyllaceæ. Mehra and Singh[7] pointed out that the multiples of the number 9 are deep-seated in Hymenophyllaceæ, besides other numbers like 13 and 33. The latter number may be based on the number 11. The present study reveals that the two genera *Salvinia* and *Azolla* possess $n = 9$ and 22 respectively. It is tempting to relegate the latter number also to the base number 11. There, thus seems to be good cytological evidence in

FIG. 1 and Explanatory Fig. 2. *Azolla pinnata*, Diakinesis $n = 22$, × 3,600. Figs. 3–5. *Salvinia natans*. Fig. 3. Diakinesis $n = 9$. Fig. 4. Anaphase 1, 9–9. Fig. 5. Tapetal cells with $2n = 18$. All figs., × 2,640.

favour of the relationship of this family with Hymenophyllaceæ. But there is a remarkable difference in size of the chromosomes in the two families. In Hymenophyllaceæ they are the largest amongst ferns[6] while in *Azolla* they are perhaps the smallest. It is also important to record that $n = 9$ is the lowest number yet recorded for a fern genus.

The writer wishes to express his gratitude to Prof. P. N. Mehra for valuable guidance and encouragement. Thanks are also due to Mr. R. S. Pathania for photomicrograph, and Mr. C. L. Khoshoo for the collection of *S. natans*.

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'CHIMERA' IN TUR (*CAJANUS CAJAN* MILLSP.)

DURING the course of genetic studies in a cross between two mutants, a creeping and a round leaf type, at the Agricultural Research Station, Niphad, District Nasik, a plant numbering 239 in the F_2 generation was observed during the season 1954-55, having very small leaves, few flowers and late in blooming. It has an abnormal structure distinctly different, as compared to either of the parental lines. Selfed seeds when sown during 1955-56 gave only two good plants, similar to the original in structure, but differing in flower and pod colour. Both plants were selfed and seeds obtained were sown in 1956-57. Two plants in the progeny gave rise to a branch having half small leaves and other half (apex side) with normal leaves, i.e., the normal leaf part differed in its phenotype from the rest of the same plant (Fig. 1).

On the close examination of the flowers from both parts, they were found normal. Selfed seeds from both the parts were collected and sown in 1957-58 season, the progenies of neither were true breeding, i.e., they exhibited non-Mendelian inheritance. The somatic cells might have mutated and given rise to new tissues and

FIG. 1

hence it may be considered a case of *Chimera*. A few similar plants have been observed in the subsequent progenies of the same cross in 1957-58 season also.

This appears to be the first instance of a *Chimera* occurring in Tur (*Cajanus cajan* Millsp.).

We are highly obliged to Prof. V. M. Chavan and Dr. S. Soloman for going through the note and giving valuable suggestions.

Agric. Res. Station, J. A. PATIL.
Niphad, Nasik, N. V. SANDBHOR.
April 17, 1958.

CHROMOSOME NUMBERS OF SOME SOUTH INDIAN SPECIES OF *VITACEAE*

THE family *Vitaceæ* comprises about 12 genera and over 500 species, mostly tropical and subtropical. Gamble (1918) has recorded seven genera and 41 species in "Flora of the Presidency of Madras". Chromosome numbers for 16 wild species belonging to 5 genera and also for the 2 cultivated species of *Vitis, viz., Vitis vinifera* L. and *V. labrusca* L., are presented in Table I.

TABLE I

	Name of Species and Variety	Counts by the author		Previous counts		Author
		2*n*	*n*	2*n*	*n*	
1	*Vitis vinifera* L.					
(i)	var. Green grape (Krishnagiri type)	38	19	38	..	Krishnaswamy *et al.* (1954)
(ii)	' Kishmish ' ('Sultana'—seedless) ..	38	19	38	..	do.
(iii)	' Red Prince ' ..	38	19	..	..	
(iv)	' Black Prince' ..	38	..	..	..	
(v)	' Habshi ' ..	38	..	..	..	
(vi)	' Anab-e-Shahi ' ..	38	..	..	..	
2	*V. labrusca* L. var. 'Bangalore Blue' ..	38	19	..	..	
3	*Ampelocissus latifolia* Planch. ..	40	20	..	20	Syamal and Patel (1953)
4	*A. tomentosa* Planch. ..	40	20	..	..	
5	*Tetrastigma sulcatum* Gamble ..	22	11	22	..	Krishnaswamy *et al.* (1954)
6	*T. lanceolarium* Planch.	44	..	44	..	
7	*Parthenocissus neilgherriensis* Planch. ..	40	..	..	..	do.
8	*Cissus quadrangularis* L. ..	24	12	24	..	Sundara Raghavan (1957)
9	*C. pallida* Planch. ..	24	12	26	..	Krishnaswamy *et al.* (1954)
10	*C. glauca* Roxb. ..	24	12	24	..	do.
11	*C. discolor* Blume ..	24	12	24	..	do.
12	*C. heyneana* Planch. ..	24	..	28	..	do.
13	*C. vitiginea* L. ..	26	13	..	..	
14	*C. adnata* Roxb. ..	48	..	..	..	
15	*C. setosa* Roxb. ..	22	11	..	..	
16	*Cayratia tenuifolia* Gagnep. ..	30	15	..	..	
17	*C. pedata* Juss. ..	C.72	..	..	..	
18	*C. carnosa* Gagnep. ..	C.98	..	..	..	

The chromosome numbers reported herein form part of a thesis presented for the award of the M.Sc. degree of the Madras University, in January 1957.

Cytogenetics Laboratory, B. V. SHETTY.
Agricultural Res. Institute,
Coimbatore, *May* 13, 1958.

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OCCURRENCE OF *CARAPA* SPP. IN THE SO-CALLED PEAT BED NEAR CALCUTTA

FOR well over a century, tree trunks, roots and other isolated plant remains have been recovered from different strata of the peat beds of Calcutta and its neighbouring areas. Excavations as reported by Oldham,[1] Blanford[2] and Ghosh[3] have revealed the existence of a peaty layer at depths of 5·5-10·7 m. not only in and around Calcutta but also further north and eastwards upto Jessore and Khulna respectively. The chief points of interest about this peaty layer are the presence of tree stumps and roots *in situ* indicating existence of a forest and the occurrence of *Heritiera* spp. as the predominant tree of this submerged forest. Lately, some specimens excavated by the Department of Archæology, Government of India, from Barisa near Calcutta, have been pronounced by Ghosh as definitely *Heritiera* spp. based on modern methods of wood anatomy.[4]

Recently, however, while examining several lumps of carbonaceous material and buried woods sent by the Director, Geological Survey of India, we have come across one specimen which is entirely different from others so far reported from the peat bed, and is described below.

The material has been collected from a horizon of carbonaceous clay, from Narayanpur Colony (lat. 22° 8', long. 88° 27') near Dum Dum, West Bengal. It is almost black in colour due to ageing. However, when split, the inner portion of the wood shows deep wine-red colour. The wood is free from any attack by fungus or insect, and is rather compact in nature with abundant deposits. It is moderately heavy (specific gravity 0·71), rather interlocked-grained, and somewhat fine-textured. The anatomical structure is distinct only under the microscope. The wood is typically diffuse-

porous. *Growth rings* are noticeable under the microscope, and are delimited by narrow initial parenchyma bands (Fig. 1), 8-11 per cm.

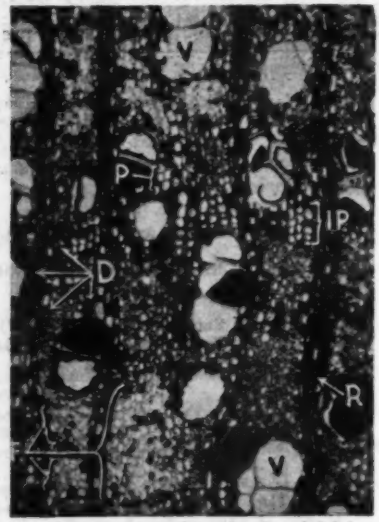

FIG. 1. Transverse section showing initial parenchyma (IP), vessels (V), rays (R), and paratracheal parenchyma (P). Note copious dark deposits (D) and deteriorated fibres (F). (×60).

Vessels are small to medium-sized, 56-140 μ in diameter, usually solitary, occasionally in radial rows of 2-4, moderately numerous, 11-18 per mm.^{2}, round to oval in outline and frequently plugged with dark gummy deposits (Fig. 1). *Parenchyma* are of two types: (a) apotracheal in concentric rows, often 3-5 cells wide (initial), but sometimes may be more than 8 cells demarcating growth rings; occasionally also diffuse but rather inconspicuous within the fibrous tissue; (b) paratracheal parenchyma is noticeable as a narrow sheath round the vessels often containing abundant brownish gummy deposits (Fig. 1). *Fibres* are often degraded (Fig. 1), non-libriform to semi-libriform, sometimes septate and filled with dark contents. *Rays* are heterogeneous (Fig. 2) and of two types—broad and high, 1-5 cells (mostly 3-4) and 45-67 μ in width and upto 35 cells or 810 μ in height; low rays 1-2 or 3 seriate, 13-15 cells (majority 10-15) and upto 450 μ in height; deposits in ray cells copious (Fig. 1). *Ripple marks* not distinct, traceable to cambiform parenchyma, short rays and sometimes vessels.

The structure described above is in close agreement with that of existing genus *Carapa* and the specimen is accordingly identified as *Carapa* spp. At present the genus *Carapa* is represented by about 12 species of evergreen trees and flourishing best in the tidal forests

FIG. 2. Tangential section cleared in Stockwell's solution to show vessel (V), fibre (F), septa (S) and ray (R). (×60).

and mangrove swamps.[5] Throughout the Sunderbans, however, the predominant tree is sundri (*Heritiera* spp.), though it is associated usually with *Carapa*, *Avicennia*, *Sonneratia*, and others.[6] *Carapas* being one of the closest associates of sundri, their occurrence in the peat bed may not, therefore, be without any significance.

Full details along with the observation on the effect of age on various cell characteristics will be published elsewhere.

Our grateful acknowledgements are due to Dr. M. S. Krishnan, former Director, Geological Survey of India, Calcutta, for supplying this interesting material for study and also helpful discussions. Our thanks are also due to Shri Krishna Lal of Wood Anatomy Branch, for constant help in the laboratory.

Forest Res. Institute, Dehra Dun, *November* 20, 1957.

S. S. GHOSH.
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REVIEWS

Transactions of the Society of Rheology, Vol. I. Edited by Bryce Maxwell and R. D. Andrews. (Interscience Publishers, Inc., New York), 1957. Pp. 222. Price $ 6.00.

Rheology is a border science in which many disciplines meet to advance polymer technology. In recent years a good deal of both theoretical and experimental work has been done in the relaxation of stress with time in amorphous and crystalline polymers and the visco-elastic behaviour of natural and synthetic rubber. It is, therefore, gratifying to see 15 original papers in the first volume of the *Transactions of the Society of Rheology.*

The first paper by J. J. Birkman is a study of the tackiness of Newtonian liquids. His experiments with 2 plates and parallel solid plates show that tackiness is governed by Stefan's equation, is determined by the rheology of the adhesive and is not affected by molecular adhesion. J. V. Robinson finds that the upper limit of volume concentration for a suspension is the reciprocal of the relative sediment volume. Papers by H. Morkovitz, R. B. Williamson and W. P. Philipps discuss the normal stress effect in polyisobutylene solutions contained in a cone and plate instrument. These results confirm Rivlin's theory of visco-elasticity and show relationship between the normal stress effect and the dynamic rigidity. Hooke's Law in shear is found to hold good upto about a shear of 20. Combined with the results of the co-axial cylinder, these may be used to classify rheological theories. S. Prager obtains stress-strain relations for a dilute suspension of dumbels, for both uniform and non-uniform velocity gradients and discusses the normal stress effect for a parabolic flow between two plates.

M. Mooney uses the published experimental data to show that the molecular thermal vibrations may be treated, after Debye, as the sum of elastic ultra-high frequency vibrations. H. M. Burte finds that strain aging embrittlement in titanium alloys may be treated by a plastic deformation giving rise to microsegregation of dissolved hydrogen. B. D. Coleman gives the mechanical model for discussing the time dependence of the mechanical strength measurements of polymer fibres. William Prager treats a mixed boundary value problem of ideal locking materials with prescribed surface displacements and surface tractions. H. L. Toor solves the energy equation for a compressible non-Newtonian liquid entering a tube at temperatures equal to the wall temperature, and shows how the distance required to closely approach the steady profile may be obtained.

E. T. Sever and J. M. Austin describe the thermal incline to measure viscosity of plastisols through a wide range of temperatures. J. P. Tordella gives the photographic study of the melt-fracture of polyethylene and finds that there is no shear fracture. Herbert Leaderman, Chairman of the Committee of Nomenclature for Linear Visco-elastic Behaviour, gives the findings of the Committee in defining the minimum number of quantities to promote uniform methods of reporting data. All workers in the field will do well to adopt the nomenclature given.

The volume is a refreshing reminder of the importance of the study of rheology to industry. In India it has been mostly studied as High Polymer Chemistry. It is time, scientists with other disciplines start paying attention to it. Chemists, physicists, applied mathematicians and mechanical engineers all will find something to interest them in these *Transactions.*

B. R. Seth.

Pressure Measurement in Vacuum Systems. By J. H. Leck. (Published by the Institute of Physics, London), 1957. Pp. 144. Price 30 *sh.*

The production and measurement of high vacua are now finding enormous applications in industry. Several recent publications on this topic have now made their appearance and to this list, the book under review is a welcome addition.

The contents of the book has been divided into six chapters. In the first five, the various methods of measurement of vacua have been given in the sequence-mechanical methods, thermal conductivity methods, ionisation methods, radiometer methods and lastly surface reaction methods. The sixth chapter deals with the topic of gauge calibration.

The mechanical methods include the various types of Mcleod gauges, their construction and methods of use. Mention has also been made of their limitations and methods of overcoming them so as to obtain satisfactory results. This chapter also includes the topic of diaphragm

manometers, their special uses and constructional details together with electronic methods of measurements of diaphragm movements.

The chapter on thermal conductivity gauges includes, besides the usual details, the particulars to secure compensation for temperature and voltage fluctuations and also data regarding the material, dimensions, and the physical features of the gauge elements. Electronic methods are described for the various measurements. An appendix to this chapter covers valuable information on the effect of heat conduction along the wire and of ambient temperature on the gauge reading.

The special features on the topic of ionisation gauges include a treatment on the relative sensitivity for different gases, the calculation of gauge sensitivity, the constructional details, electronic control circuits, the cold cathode gauge and the alphatron.

The theory of the radiometer gauge, its experimental verification and the practical developments of the Knudsen gauge by later workers are described on radiometer methods.

The chapter on surface reaction techniques and their application in the measurement of vacua is a good contribution to the subject especially when measurements of pressure below 10^{-10} mm. have to be made. This topic is dealt with under three main sections, namely, (1) by observations on changes in the surface—work—function, (2) by measuring the quantity of gas removed by flashing a filament at fixed intervals, and (3) by point emission microscope studies.

The concluding chapter is on gauge calibration and is in two sections, one for the range 10 to 10^{-3} mm. and the other 10^{-3} to 10^{-6} mm. The methods adopted in the latter case are rather indirect.

The author contends that this work is solely intended to cover the topic of measurement of low pressure. One interested in these techniques would naturally feel that in a book of this type at least a few introductory pages dealing with the latest methods of production of high vacua would have been a very desirable feature.

The book is written to a high standard and contains, in addition to a theoretical background, the practical aspects of gauge design. A post-graduate engaged in the working of high vacuum plants will find ample and useful information in this field. The get-up is nice, quite a number of descriptive sketches are given and at the end, the book contains useful and recent references for the matter contained in each chapter.

S. HARIHARAN.

Flame Photometry—A Manual of Methods and Applications. By F. Barriel-Marti, J. Ramirez-Munoz. (Elsevier Publishing Co., Cleaver-Hume Press, Ltd., 31, Wright's Lane, London W. 8), 1958. Pp. xii + 531. Price 65 *sh.*

Although flame test as a qualitative analytical tool has been known from the days of Bunsen and Kirchoff who first introduced it, its ascendancy to the status of a quantitative method is a recent development. The work of Lundégardh has contributed greatly to the evolution of flame technique. Today, it is a very important tool enabling accurate and quick determinations of a large number of chemical elements although in the initial stages, the method was directed to estimations of alkali metals only.

Flame methods do not claim a superiority over other methods, such as spectral analysis with the arc or the spare, but the method has certain inherent simplicity and advantages. The number of lines excited are fewer, results are highly reproducible and amongst all spectrum sources, the flame has got the greatest stability. Further, in certain estimations of a routine nature, very simple apparatus is only required and is thus a very inexpensive method compared to others. The preparation of the sample and the method of introduction of solution as a spray into the flame are the two vital aspects to the success of the method in accurate estimations.

The book under review deals with the flame method of analysis by direct photometry. The contents are presented under six parts, (1) Origin and Principles of Flame Photometry, (2) Analysis by Flame Photometry, (3) Instrumental Systems, (4) Extent and Limitations of Flame Photometry, (5) Experimental Method, and (6) Analytical Applications.

The book covers under the above five heading all aspects of Flame Photometry to the minutest detail, and, in the opinion of the reviewer, is a very authoritative and thorough treatment on the subject.

Since the range of application of Flame Photometry as an analytical tool extends over a wide field, *viz.*, biological, industrial, pharmaceutical, clinical, soil and agricultural chemistry, this book would be found as an invaluable guide to all those who are already using or contemplate using this method.

A comprehensive bibliography is appended at the end, which includes as many as 909 references. The get-up of the book is excellent and, considering the usefulness of the same, the price of 65 *sh.* is quite moderate.

A. J.

Introduction to Fourier Analysis and Generalised Functions. By M. J. Lighthill. (Cambridge University Press), 1958. Pp. viii + 79. Price 17 *sh.* 6 d.

The subject of generalised functions, like that of Heaviside's operational calculus, is one in which the applications have preceded the development of a rigorous mathematical theory. The best known example of a generalised function is the δ-function of Dirac, $\delta(x)$, which is defined as zero for all values of the argument x except $x = 0$ where it becomes infinite in such a way that $\int_{\infty}^{-\infty} \delta(x)dx = 1$. Mathematically this definition is devoid of meaning in any sense an integral is understood. There was never any doubt, however, about the utility of the δ-function (when used with caution) as it serves as the mathematical model for certain idealised physical concepts like a point-source, an impulse, etc. One could not, nevertheless, conceal the feeling of uneasiness in the use of this function as there was no way until recently of justifying the operations performed on this function. As rightly emphasised by Prof. Friedmann, it is, therefore, the mathematician's task to find a method by which the use of the δ-function (and other generalised functions) could be justified.

There have appeared during the past decade or so several successful attempts to provide a basis for the justification. The most celebrated of these due to Laurent Schwartz regards the generalised functions (and their derivatives) as linear continuous functionals (called distributions) over the space of test functions having suitably chosen properties. The method adopted in this book is based on the representation of generalised functions (and their derivatives) by means of approximating sequences of regular functions and follows the exposition given by Temple elsewhere. The book gives a concise exposition of the theory of generalised functions, their properties, and their Fourier transforms. The representation of generalised functions by Fourier series is discussed in considerable detail with several special functions chosen for examples. This short Cambridge monograph (one of the series on Mechanics and Applied Mathematics) is primarily addressed to the mathematical reader but remains accessible to the theoretical physicist and engineer. The reviewer, however, feels that the size (and even the price) of the book leaves enough room for the inclusion of a chapter on the use of the generalised functions in the solution of physical problems.

B. S. RAMAKRISHNA.

Tracer Applications for the Study of Organic Reactions. By John G. Burr, Jr. (Interscience Publishers, New York), 1957. Pp. x + 291 (11 Tables). Price $ 7.50.

Isotopic tracers, both stable and radioactive, have in recent years become a powerful research tool in biological problems, but their use in organic chemistry has been comparatively limited. However, with the growing realisation of their potentialities in the determination of reaction mechanisms, quantitative analysis and elucidation of structures where employment of other techniques fails to provide unambiguous answers, the tracers are beginning to find an important place in the repertoire of the organic chemist along with IR absorption and electron diffraction analysis, NMR and gas chromatography.

One of the reasons for the less widespread application of this technique is perhaps to be found in an exaggerated sense of hazard and difficulties encountered in the use of isotopes, another being the lack of good literature reviews and text-books on the subject exclusively for the use of organic chemists. John G. Burr (Jr.), author of the book under review, in meeting this need, has done an able and worthy job and has produced what has turned out to be more than a "reasonably comprehensive survey of tracer applications in organic chemistry". The book is however not for the uninitiated in the use of tracers, but is meant mainly for the organic chemist whose problem, as the author would have it, is an organic reaction rather than use of an isotope. However, this defect, if at all, has been largely mitigated by the well-chosen list of reading material, by way of text-books and review articles, contained in Appendix A which provides a good coverage of the nature, properties, handling and analysis of stable and radioactive isotopes. In addition, the opening chapter of the book deals exclusively with some general considerations regarding the function of tracers, the specific types of situations where isotopic methods are superior or indispensable and carries an excellent concluding section on the nature of the results obtained by isotopic methods and the factors affecting their validity. The latter clearly brings home to the young enthusiast that the tracer methods should not be used for trivial investigations, but confined only to those situations where an answer cannot be had conveniently or unambiguously by the application of orthodox techniques.

In the succeeding dozen chapters, "the isotope applications have been arranged according

to the reaction classifications most familiar to the organic chemist". In order to provide adequate coverage of background material for an intelligent appreciation of the discussion of isotopic applications to the various reactions treated in these chapters, the author has thoughtfully added at the end of the book (Appendix B) a list of the better known texts on organic reaction mechanisms which would be found extremely useful. Apart from the references given at the end of each chapter, there is an Appendix C with more references, classified according to each chapter heading, and these together bring the literature coverage upto early 1955.

The get-up of the book is in the tradition of Interscience Publishers and but for a rare misprint or two, the text is carefully edited. It is extremely informative and therefore deserves a place in an organic chemist's bookshelf.

R. K. M.

The Strategy of Chemotherapy. (The Eighth Symposium of the Society for General Microbiology, held at the Royal Institute, London.) (Cambridge University Press), 1958. Pp. vii + 360. Price 35 *sh.*

Symposia of this type are of interest to workers belonging to different disciplines. The success in chemotherapy, though phenomenal, has, so far been entirely due to accidental discoveries or empirical studies. The comparative failure of logical chemotherapy is due to the gaps in our knowledge of metabolism of both host and invaders and our neglect of the responses of the host.

Since chemotherapy is based on the interaction of chemical substances with biological systems, the introductory chapter by Woods and Tucker initiates the discussion by a presentation of the biochemical principles which could profitably be investigated for successful chemotherapy. The need for the discovery of new and effective antibiotics, the future potentialities of random methods and controlled biosynthesis techniques are discussed by Woodruff and McDaniel in the 'Antibiotic Approach to Chemotherapy'.

Selective inhibition of bacterial cell-wall synthesis, surface active bactericides, membrane penetration and therapeutic value of chemicals, inhibitors of energy supplying reactions, metal binding agents in chemotherapy, the designing of antimetabolites, lethal synthesis and specific inhibitors of protein synthesis, are the titles of some papers in the symposia. They present in detail the possible methods by which the microbes in general may be attacked and offer the explanation for and prospects of their selective action against the microbe.

The remaining papers deal with particular problems of certain groups of micro-organisms and include the selective inhibition of viral multiplication, the chemotherapy of bacterial infections, fungal diseases, of some protozoal infections and of factors affecting the chemotherapy of amœbiasis.

Besides presenting a critical and exhaustive survey of the present-day chemotherapic approach, a significant feature of the symposia has been the emphasis laid on the need for accumulation of more fundamental data and the high optimism of the contributors in the future success of rationale approach to chemotherapy.

M. SIRSI.

Yeasts. Edited by W. Roman. (Dr. W. Junk, Publishers, Hague), 1957. Pp. 246. Price 25 Guilders.

Yeasts is the first volume of the series in *Biologia et Industria* planned with the laudable object of bridging the gulf between academic research and industrial practices. The biology, biochemistry and technology of Baker's, Brewer's, Wine, Sake, Food and Fodder Yeasts are given. The contributions, however, are not of the same standard. The classification into Brewer's and Baker's yeasts is arbitrary since they are only varieties of *Saccharomyces cerevisiæ*. The treatment of the subject on the old empirical classification has led to repetitions in different sections.

The references given in most chapters end with the year 1954 though the book was published in 1957. The section on Cytology and Cytochemistry which may appear objective to a lay reader is vitiated by an incorrect appreciation of the earlier literature. The first report on the presence of a nucleus in yeast (Nageli, 1944), was from living cells. A vesicular nucleus with a nuclear membrane was described as far back as 1896 from living as well as stained cells. Confirmation of these discoveries have been published in 1956. And yet the suggestion is offered that like the naked chromosomes of bacteria, "the discrete granules revealed by ultraviolet microscopy may, in fact, represent the true condition of the nuclear apparatus of a yeast cell" (p. 43).

The get-up of the book is good but the large number of printer's devils and even displace-

ment of portions of sentences (pp. 107, 108, 109) may irritate a reader. The chapters on Wine, Sake, Food and Fodder Yeasts are claimed by the publishers to be the outstanding features of the book.

M. K. SUBRAMANIAM.

Cosmetics : Science and Technology. Edited by Edward Sagarin. (Contributions by sixty-one authors.) (Interscience Publishers, Inc., New York-1 ; 88/90, Chancery Lane, London, W.C. 2), 1957. Cloth bound, Royal 8vo. Pp. xix + 1433 including indices and bibliographies. Price $ 25.00.

The last two decades have witnessed an ever-increasing number of authentic and original publications in English language dealing with almost every branch of advanced scientific and technological subjects. But the recorded literature in cosmetic science lags far behind its actual progress in research and technology. With the three notable exceptions by M. G. de Navarre and R. G. Harry, published in English in the early 1940's and followed later by two Cosmetic Compendia by E. G. Thomssen and S. P. Jannaway, the cosmetic chemists and the manufacturers had no other source to fill the serious gap of advanced scientific information on cosmetics. The latest publication of this heavy volume is, therefore, not only opportune, but also most welcome.

By contrast, the Editorial Board of this volume including, besides the celebrated author and executive, Edward Sagarin, three eminent cosmeticologists, *viz.*, H. D. Goulden, E. G. Klarmann and Donald H. Powers, felt the need for a work of collective nature. In their preface to the volume, the learned editors have very aptly pointed out the limitations of some chemists who are well versed in certain types of cosmetics, but may possess comparatively little knowledge of others. Out of this realisation, by the Board of Editors, grew their determination to bring together a number of authorities each of whom has an established reputation for familiarity with some special phase of cosmetics, or of some related science or technique. Thus, has emerged the first collective volume in the history of cosmetic literature, compiled by the team contributions of fifty-three separate chapters by a galaxy of sixty-one men and women engaged in research and industry in the field of cosmetics. To add further to the thoroughness of the scientific and technical information contained in this volume, the Editorial Board deserves to be highly complimented for having liberally drawn upon their resourcefulness in having several chapters reviewed by a large number of leading scientists and technologists in the field of cosmeticology.

The volume is suitably divided into five main sections, *viz.*, (*i*) three chapters dealing with the Scope of Cosmetics ; (*ii*) Toilet preparations described in thirty-five groups of different types of cosmetics ; (*iii*) Manufacture and technology covering six chapters ; (*iv*) Physiological considerations condensed into five chapters, and lastly (*v*) Legal considerations in four chapters. With such a vast and diverse scope and extent of its contents, this volume is, on the whole, an excellent addition to the rather scanty literature on cosmetics in English and is also very reasonably priced. Clear photographic illustrations, flawless printing and get-up and a strong binding have left nothing desired. A larger number of photographs and suitable flow-sheet diagrams of the chemical engineering operations could not perhaps be included due to the otherwise heavy bulk of the volume.

The three chapters in Part I on the Scope of Cosmetics are, on the whole, most thought-provoking and illuminating. Aptly sandwiched between a concise account of Definitions and Limitations by Hugo Mock and a masterly account of the Status and Structure of the Cosmetic Industry by Edward Sagarin, is a very fascinating historical account on the Origin and Development of Cosmetic Science and Technology by its erudite and learned writer, Miss Florence E. Wall. This chapter with its eighty-eight references gives a precise wealth of information on the early history of Cosmetics, and is the best that the reviewer has ever come across on the subject. References to early history of cosmetics in India are also aptly and intelligently included.

The individual Toilet Preparations described in detail in Part II of the volume, are impressive illustrations, not only of the magnitude of the cosmetic industry but also of the exacting task undertaken by their respective writers. Edward J. Master's contribution on Cleansing Creams and Lotions, spread over seventeen pages, gives a lot of useful information. Cold Creams have, in fact, been very well treated though, as it appears, at the cost of Lotions. Forty-seven pages have been ably contributed by Gabriel Barnett on the subject of Emollient Creams and Lotions, their formulation and manufacturing details. On the whole, this chapter makes a very informative reading. This is followed by an excellent chapter on Hand

Creams and Lotions by S. J. Strianse. In thirty-five pages of this chapter, the writer has classified the various ingredients used in the formulation of hand preparations according to its most specific feature and has offered very balanced and thoughtful comments. C. W. Ozier's short chapter on Skin Lighteners and Bleach Creams is as interesting as brief. Jean R. L. Martin's excellent account of Face Powders, colouring methods and colour shades in vogue for these items is disappointing in respect of information on perfuming of face powders. Lauffer on Lipsticks; Gershon and others on Dentifrices; Rosenthal on Mouthwashes; Powers on Shampoos; Guest on Shaving Soaps and Creams; Bell on Preshave and Aftershave Preparations; Barry on Depilatories; Lehne on Hair Grooming Preparations; Gershon and others on Permanent Waving, etc., have all contributed as entertaining and informative write-ups as one could desire. Miss Florence E. Wall has further contributed an able chapter on Bleaches, Hair Colorings and Dye Removers. Davenport's treatment of Bath Preparations is rather sketchy. Robert F. Schuler's chapter on Emulsified and Solid Fragrances is quite impressive. However, author's reference to glycerine as a solvent for perfume oils is rather intriguing as glycerine is an exceedingly poor solvent for most of the terpene oils and aromatics. Edward Sagarin's excellent chapter on Fragrance deals effectively with the raw materials, life of a fragrance, fixation, problems of formulation, etc. Sagarin, as usual, has displayed his excellent style and mastery of facts and problems in his write-up. The chapter on Aerosol Cosmetics by H. R. Shepherd is a novel and very useful feature of the book. Over fifty pages on this subject are very well written and cover almost all the features of Aerosols for the first time in the history of cosmetic literature. Barnett's treatment of Baby Toiletries is also full of useful information.

In Part III, ably written and thought-provoking chapters on Plant Layout and Equipment, Quality Control, Performance and Evaluation of Cosmetics, Preservation of Cosmetics and Color in Cosmetics have been contributed by leading experts in the respective fields. The two chapters on Quality Control by Martin A. Brumbaugh and his colleagues and on Performance and Evaluation of Cosmetics by Dean Foster and Noel Schwartz are the outshining contributions towards much desired standardisation of cosmetics, their performance, raw material specifications, testing, sampling, etc. The authors have much enhanced the utility of the book by their valued and scientific write-ups. This part also contains a chapter of some thirty-five pages on Emulsification by William C. Griffin. The author has given some excellent photographs depicting viscosity changes and particle size and has made a bold attempt to explain almost every phase of this ocmplex phenomenon. The overall impression left by the author is that the subject of emulsification has never received any scientific approach and that our present knowledge is only the result of rule-of-thumb methods. The classic work of Rideal, Schulman, etc., to which incidentally no reference has been made by the author, convincingly proves that this is not so.

Part IV on Physiological Considerations comprises well-written five chapters, ably handled and full of useful information to all Cosmetic Chemists.

The information given on Legal Considerations under the concluding Part V is concise though much of it is bound to be redundant even before the first revision of the book becomes feasible.

"Cosmetics: Science and Technology" is, on the whole, an admirable venture of its kind. The reviewer wishes it all success and hopes that, before long, its copies should be in possession of all research laboratories, cosmetic chemists and manufacturers.

SADGOPAL.

Books Received

Infrared Absorption Spectra of Steroids—An Atlas, Vol. II. By Glyn Roberts, Beatrice S. Gallagher and R. Normon Jones. (Interscience Publishers, New York-1, N.Y.), 1958. Pp. viii + 95. Price $ 20.00.

Antibiotics Annual. Edited by Henry Welch and F. Marti-Ibenes. (Medical Encyclopedia, Inc., New York, N.Y.), 1958. Pp. xvii + 1070. Price $ 12.00.

Methods of Biochemical Analysis, Vol. VI. Edited by David Glick. (Interscience Publishers, New York), 1958. Pp. ix + 358. Price $ 8.50.

Chemical Analysis—Colorimetric Determination of Non-Metals, Vol. VIII. Edited by David F. Boltz. (Interscience Publishers, New York), 1958. Pp. xii + 372. Price $ 8.50.

The Chemistry and Biology of Yeasts. Edited by A. H. Cook. (Academic Press, Inc.; India: Asia Publishing House, Bombay-1), 1958. Pp. xii + 763. Price $ 22.00.

SCIENCE NOTES AND NEWS

Chromosome Numbers of Two Common Weeds

Dr. S. W. Mensinkai reports that during the cytological work on the weeds of the College Farm, at the College of Agriculture, Dharwar, it has been possible to ascertain for the first time the haploid chromosome numbers from the flower-buds of the two common weeds: (1) *Trichodesma zeylanicum*, and (2) *Acanthospermum hispidum*. The former is an erect annual herb about 2' high belonging to *Boraginaceæ*. It is a khariff weed of the medium black cotton soil flowering on the Farm at the end of December and not in the month of January, as stated by Hooker. *A hispidum* (*Compositeæ*) is an exotic annual herb about 2' high, covered with hairs and dichotomously branched. The plants begin to flower from August and continue upto March. It is a weed noticed in almost all dryland areas.

The flower-buds were fixed in acetic-alcohol mixture 1 : 3 and stained in iron-aceto-carmine. In *T. zeylanicum*, the haploid number counted was 12 and in *A. hispidum*, $n = 11$.

Archaeological Non-Corrosion

Metal relics which have been buried in the earth for centuries have led to the evolution of a new protection against corrosion for various kinds of steelwork which is in constant contact with dampness. The archæological finds are known now to have been preserved by the presence of vegetable tannins in the soil.

They form a coating of tannates on the metal which protects it not only against chemical corrosion, but also against the corrosive action of bacteria. A tannin phosphate has been produced to serve the same purpose for application by immersion or with a brush to things like steel pipelines, storage tanks and such steel work as is hard to reach when installed.

New Process for Electro Refining Nickel

Research scientists and engineers of the International Nickel Company of Canada, Limited, have developed a new process for the electro-refining of nickel.

A main feature of the process is the direct electrolysis of nickel matte, an artificial sulfide. This contrasts with the usual electro-refining methods, including those employed in the nickel industry, in which a metal anode is used. The new Inco process eliminates high-temperature oxidation and reduction operations, with attendant losses of metals and sulphur and selenium. Instead, nickel sulfide of low copper content from the Bessemer converter or other source can be cast directly into sulfide anodes and electrolyzed for the production of high quality nickel. Another unique feature of the process is that it permits, for the first time in nickel refining, the commercial recovery of elemental sulfur and selenium as valuable by-products, in addition to cobalt and precious metals conventionally recovered.

The interesting possibilities of the new method were first demonstrated in Inco Laboratory tests in 1951, when a small piece of cast nickel sulfide was electrolyzed. It corroded smoothly the nickel and other base metals passing into solution, leaving a precious metal-bearing anode sludge containing 97% elemental sulfur.

A number of obstacles to the recovery of sulfur of high purity from the sludge were resolved by laboratory and pilot plant investigations. These studies, conducted jointly with Blaw-Knox Company, resulted in the construction of a novel 100-tons-per-day sulfur fractional distillation unit. The sulfur from this unit contains less than five parts per million of selenium and has an unusually low ash and bitumen content.

Sulfur : A Possible Metallic Form

Sulfur is normally an excellent insulator. But in spite of its high specific resistance ($> 10^{18}$ ohm cm.) it appears to be an intrinsic semiconductor, and its position in the periodic system suggests that it might even exist in a metallic state under favourable conditions. There is evidence that its neighbour, phosphorus, undergoes a reversible change into a metallic form at about 40,000 atoms, and Bridgman has looked for a corresponding transformation in sulfur at high pressures. He found no sign of a transition below 100,000 atoms.

It is reported that sulfur subjected to shock pressures of about 230,000 atoms, exhibited strong indications of metallic conduction under these conditions. (*J. Chem. Phy*) **28**, No. 5, May 58, p. 1006.)

Extraction of Helium from Gas Mixtures

During the Fifth International Conference on Low Temperature Physics and Chemistry, held at Madison, Wisconsin, in 1957, concern was expressed because at present only a small proportion of helium is extracted from the considerable volume of helium-rich natural gas that is used as a fuel, so that a large proportion of our limited helium resources is being wasted. In a new and simple method of extracting helium that is being developed by K. B. McAfee, of the Bell Telephone Laboratories, the fact is made use of that under high pressure difference helium will diffuse fairly rapidly through a thin wall of silica or 'Pyrex' glass, especially if it is at a high temperature but not other gases.

With a pressure difference of 1,000 atmospheres, a practical cell containing capillaries occupying a volume of about 2 cu. yd. could extract from a 1% mixture about 1,000 cu. ft. of helium per day at room temperature and about 100,000 cu. ft. at 400° C. It is suggested that all the helium-rich natural gas that is collected could easily be passed through such cells. The resulting helium is very pure, and the process could also be used simply for purification.

Electron Phase Microscope

Since the beginning of electron microscope, it has been well known that the phase contrast due to the interference of the coherent wave plays a very important role in image formation. In view of Zernike's theory of the phase difference microscope, if an appropriate phase plate is inserted into the back focal plane of the objective and, in addition, if it is possible to cause a phase difference whether in the transmitted wave or the diffracted one, it is reasonable to expect that it is possible to make a phase microscope. According to calculation, a collodion film 100 Å in tihckness, is seen to result in a phase delay of the order of $\pi/2$ provided that the accelerating potential is 60 kv. For this reason, it is necessary that the phase plate be very thin. For this phase plate, a hole in the collodion membrane or a disc on a thin collodion membrane may be suitable for dark or bright contrast observations. For several reasons however, it is seen that a phase plate with holes may be considered to be superior to that without holes.

It is shown that observation by dark contrast image using a phase plate, consisting of many holes in a carbon membrane is very suitable for microtome section specimens, as well as for thin crystal specimens without a decrease in resolving power. (*J. App. Physics*, **29**, p. 1046.)

Contact Stresses

So many engineering devices, such as toothed gears, rolling bearings and the wheel itself, operate by the transmission of large forces between surfaces in contact over a relatively small area, that a knowledge of the local stresses set up in the region of such contacts is obviously of wide interest.

Apart from the inspired, and now classical, theory of elastic contact presented by Hertz in 1881, there have been until recently very few contributions to the theoretical structure of the subject so beloved of academic investigators. In consequence, the engineering designer has been obliged to develop his own empirical rules and to conduct his own comparative tests to avoid the undesirable consequences of excessive contact stresses: pitting, scuffing, fretting or simple wear.

The past few years, however, have seen considerable advances in the theory of contact stresses. A number of solutions have been found, arising, as so often is the case, from investigations in other fields, to the problem of contact of both ideally elastic and ideally plastic solids under the action of various systems of forces. The basis for more fundamental and revealing studies of the mechanism of surface breakdown under contact loads appears to have been laid, and it is likely that more satisfactory explanations of pitting and other surface failures are not too remote. Even the study of metallic friction and wear, which has attracted scientific work of high quality over a number of years, has benefited from recent theoretical studies.

Yet the Symposium organized by the Stress Analysis Group, and held at the Institute of Physics, on May 14, appears to have been the first in Britain to be devoted specifically to the topic of "Contact Stresses".

Organic Tin Compound as a Crop Fungicide

The fungicidal properties of organo-tin compounds with quadrivalent tin were discovered by Van der Kerk and Luijten and described by them in detail in 1954. They found that exceptional fungicidal activity characterised certain organo-tin compounds of the general formula R_1, R_2, $R_3S_nX_1$, where 'R' is an organic radical linked by one of its carbons to the tin atom, and 'X' is an organic or inorganic radical not linked to the tin by carbon. The nature of the hydrocarbon radicals, R_1, R_2 and R_3 has a decisive influence on the degree of the

fungitoxic effect but the group X has not much influence. Tributyl—and isopropyl-tin compounds have the greatest fungicidal effect *in vitro* but are strongly toxic to plants.

Following the excellent fungicidal tests with triaryl-tin compounds under natural conditions, further outdoor tests confirmed that triphenyl-tin compounds were very promising agricultural fungicides. A preparation based upon triphenyl-tin acetate, under the name "V.P. 19-40", was given official trials in 1953-54, and, after this, it was thoroughly tested at the Biologische Bundesanstalt, Braunschweig, where it was acknowledged to be effective at 1·8 kg. per hectare (in a 0·3% spray) against Cercospora in beets and against Phytophthora in potatoes. This preparation was then registered under the trade mark "Brestan" in the catalogue of plant preservatives of the Biologische Bundesanstalt. It is now available in limited quantities to agriculture for trial purposes.

Thermoelectric Cooling

Locked in the laboratory since its theoretical discovery by Peltier in 1834, a practical method of producing electronic refrigeration has been the goal of scientists throughout the world. The principle is that simply passing electricity through junctions of two dissimilar metals creates heating or cooling depending on the current's direction. Until now, the problem has been to find a practical and efficient way to do this. Besides, the advantage of smaller size, the electronic method is noise- and vibration-free, simple to control and capable of almost instant temperature change at the junctions.

These devices represent a new source of cold. We clearly foresee the day not too far in the future when thermo-electric cooling will replace the conventional compressor as a 'cold-maker'.

A New High Temperature Alloy

A new, improved high temperature alloy known as Carpenter Lepelloy "C", has been developed by The Carpenter Steel Company, Reading, Pa., for jet engine parts requiring excellent ductility and good impact resistance.

Carpenter Lapelloy "C" has a more homogeneous structure and more uniform fabrication behaviour and mechanical properties than the conventional Lepelloy. It is used for highly stressed parts involving service temperatures up to 1,200° F. Lapelloy "C" has greater ductility and impact strength at both room and elevated temperatures than conventional Lapelloy when heat treated to the same strength level.

High mechanical properties can be developed by heat treatment. It has good resistance to scaling and oxidation for continuous service up to 1400° F. The alloy offers best corrosion resistance when in the hardened and tempered condition. It is used for compressor wheels, turbine shafts, compressor buckets, blades, and bolts.

Type analysis of Carpenter Lapelloy "C" is: Carbon, 0·20-0·25%; Manganese, 0·65-1·00%; Silicon, 0·50% max.; Chromium, 11·00-12·00%; Nickel, 0·50% max.; Molybdenum, 2·50-3·00%; Copper, 1·75-2·25%, and Nitrogen, 0·06-0·10%. [*J. Fran. Inst.*, June 1958, **265** (6), 523.]

Testing and Standardisation of Foundry Materials

Under the auspices of the Bangalore Chapter of the Indian Institute of Metals, a Symposium on the above subject will be held on the 9th and 10th October 1958, at the Indian Institute of Science, Bangalore.

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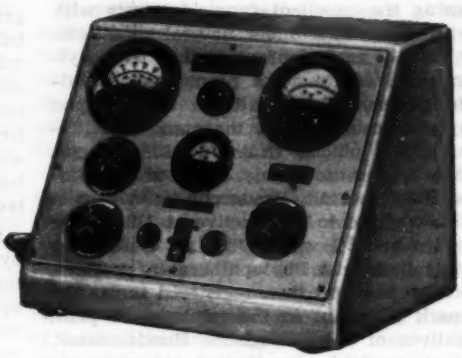

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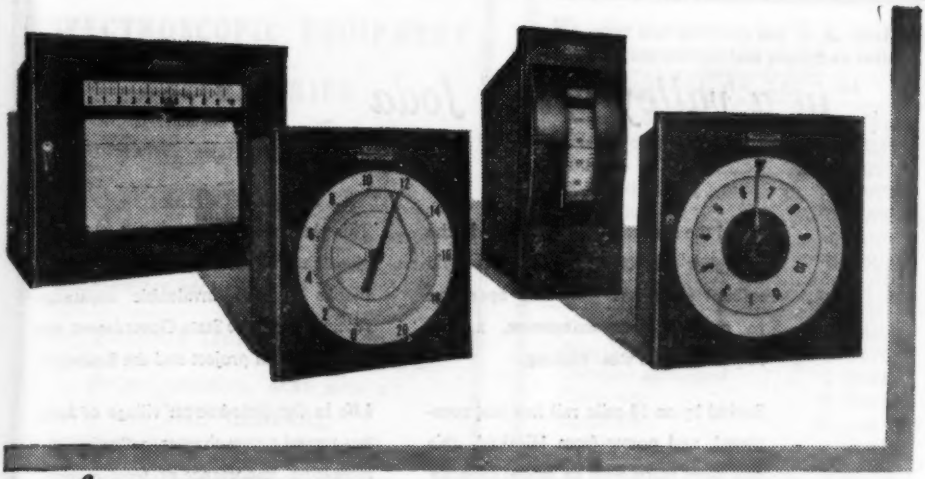

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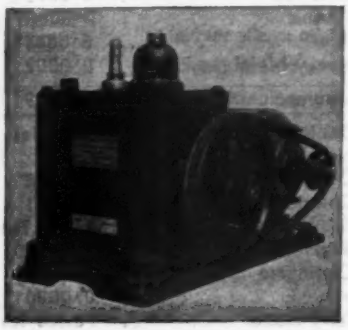

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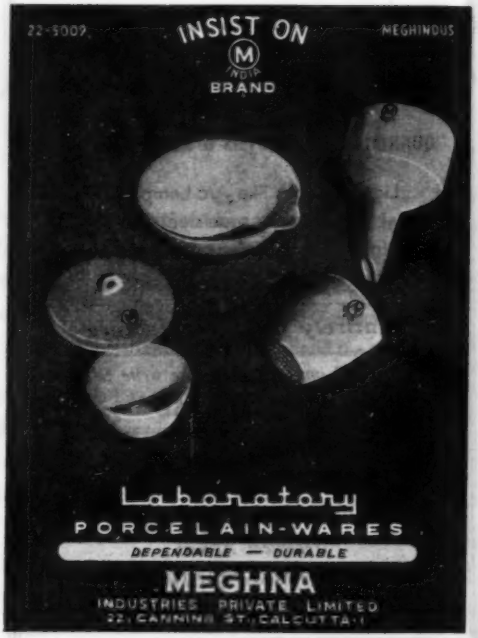

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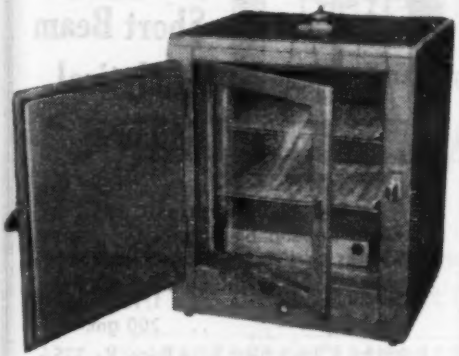

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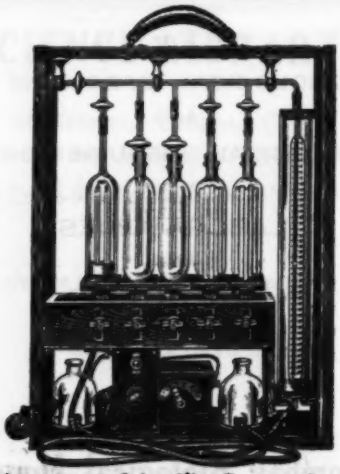

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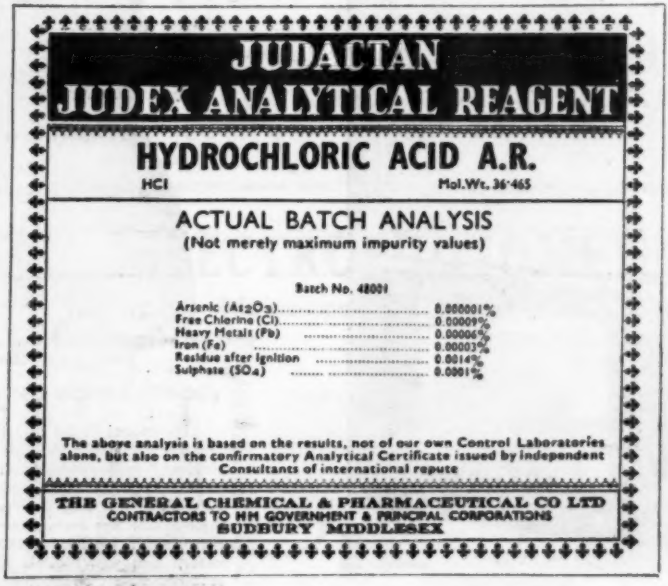
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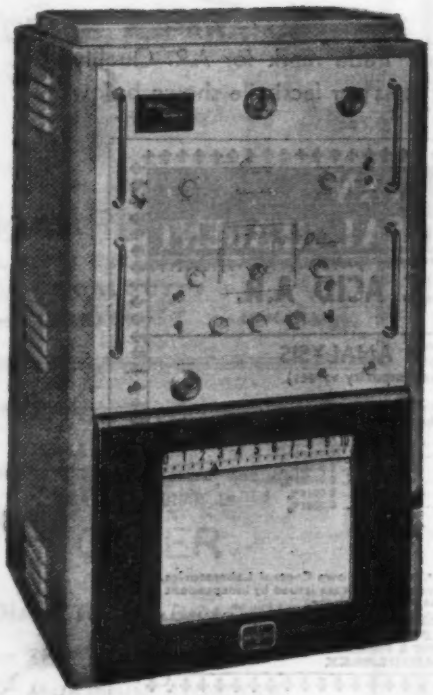

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